HAND BOOK

OF

INDUSTRIAL DRAWING

IDA A. TEW

Express Publishing Company

Beatrice, Neb.

HAND-BOOK

— OF —

INDUSTRIAL DRAWING

FOR TEACHERS IN COMMON SCHOOLS.

BY IDA A. TEW,

SUPERVISOR OF DRAWING IN PUBLIC SCHOOLS, BEATRICE, NEBRASKA.

BEATRICE, NEB.:
EXPRESS PUBLISHING COMPANY,
1894.

CONTENTS.

Introduction, - - - - - 5
Geometric Definitions, - - - - 11
Construction of Simple, Plane Figures without the Use of Compasses, - - - - 22
Plane Figures to be Constructed Accurately with Instruments, - - - - - 26
Working Drawings, - - - - 30
Development, - - - - - 39
Botanical Drawing, - - - - - 47
Designs, - - - - - - 50
Historic Ornament, - - - - - 57
Color, - - - - - - 63
Representative or Pictorial Drawing, - - - 69
Paper Folding, - - - - - - 96
Clay Molding, - - - - - - 104
Stick Laying, - - - - - - - 108

INTRODUCTION.

This book is intended merely as a bird's eye view of the subject of industrial drawing as it is taught in the public schools. It aims to aid the teacher in gaining a little knowledge concerning each department into which the subject is divided. It does not claim to be even an attempt at covering the ground in anything like a comprehensive way, but it will give the teacher a starting-point, at least, from which to pursue the subject in all its branches.

While doing Institute work the author has been asked numberless times to designate some book which would give an all-round glimpse of drawing, and while there are many books treating of any one of the topics considered in this book, they are treated so comprehensively that the teacher is discouraged at the thought of the mass of material she must read to get what she really wants; and in order to know even a little of each of the topics to be considered she must read as many books as there are divisions of the subject, and it is this that has led the author to give this little book to the public, in the hope that the teacher may find in it the points in drawing which it is necessary she should know.

It is often asked, "Why teach drawing in the public schools?" Drawing has long been looked upon as a merely ornamental study, and as such of little value from an educational standpoint; but, at last, we have awakened to the fact that drawing as an accomplishment, is a very small part of

a very large subject, and we indicate this when we denominate the subject as taught in the public schools, *industrial drawing.*

The true aim of education is to cultivate the faculties in all directions, and drawing has been found to be a very important factor in this work in the cultivation of observation, memory, imagination and imitation, and also in awakening the power and dexterity of the hand in the work of construction.

It is of value, too, as a means of thought expression; it being possible to show at a glance by a drawing what could not otherwise be told except by lengthy description, and perhaps even then not adequately expressed.

Drawing has been aptly called the "universal language." Learning to draw is learning to see, and the seeing must always outrun the drawing.

When any object is seen in its correct proportions and form it is easy to make a representation of it.

One day a class of teachers were asked to make a memory drawing of a half-apple. The form was drawn without difficulty, then came the question from one of the members of the class, "Which way do the seeds point, toward the stem or toward the bud?" Out of a large class but few were positive in their knowledge on this point. We have found that many people, even among those who have spent a large part of their lives upon a farm, are uncertain whether a cow's horns are in front of, or behind the ears.

One day a cube was shown to a class and the question asked "Do you really know the cube?" All thought they

undoubtedly did. The cube was then put out of sight and the class were asked "How many corners has the cube?" There was a visible effort to recall the image to memory, and after a moment's hesitation, while many answered correctly, several could not tell the exact number.

This ignorance is merely the result of not having been trained to habits of careful observation.

"Seeing, we see not."

Madame Cave says, "As soon as you see correctly, you feel correctly, you execute correctly. If you follow your eye, your observation, you will secure correctness, you will find truth, you will be natural, and naturalness is simply truth. This accuracy, this naturalness, is the result of much observation, of great memory."

Rubens says, "To see, to understand, to remember, is to know."

Besides its value as an educational factor in the training of the mind and eye, drawing is of little less importance as an educator of the hand. Man has been distinguished from all other animals by his manual dexterity; he is primarily a constructive being. This tendency which shows in the child at a very early age, finds a natural outlet in the work in drawing, especially in Geometric or Constructive drawing.

A boy or girl who has had thorough instruction in industrial drawing has been given a much wider range from which to choose his life work. In towns where there is little manufacturing the boy has almost no choice except between the store and the office, but if his mind has been awakened to that great field which drawing opens to him, he can choose

the place for which he feels nature has fitted him. The girl who has energy and perseverance need no longer feel that the schoolroom or the office is the only place for her. The girl and the boy have the choice of the mechanic arts, architecture and draughting; the decorative arts, designing, frescoing, lettering; the plastic arts, modeling, carving, sculpture; and the reproductive arts, etching, engraving, lithographing and photography.

Drawing as taught in the public schools, cannot, of course, give the pupil even an elementary knowledge of these branches, any more than the penmanship taught in school will give him a knowledge of business forms that would make him at once capable of filling a bank cashier's place, but it will train his mind, his eye, his hand, so that if he possesses some taste for drawing, and earnestness of purpose, and chooses to enter the industrial arts he will make his work a success.

For the teacher, a knowledge of the elements of drawing and the ability to use the pencil or crayon graphically is of immense advantage. There is no branch of learning to which the teacher cannot apply it with advantage to the youngest as well as the oldest pupils.

The time has come when the state has recognized the necessity of teachers having some knowledge of drawing and has emphasized it by requiring them to pass an examination in this branch. The opportunities for the study of drawing have been very limited for teachers who have not had a professional training, and this little book is offered as an aid to assist them over some of the hard places and perchance to tempt them to a farther study of this fascinating subject.

Industrial Drawing is divided into three departments: I. Constructive Drawing. II. Decorative Drawing. III. Pictorial Drawing.

I. Constructive, or Geometric Drawing includes the study of geometric definitions and problems, working drawings, and development of surfaces.

II. Decorative Drawing or Ornament includes the study of plant forms, and their conventionalization, elementary design, historic ornament, and color.

III. Pictorial Drawing or Representation treats of the representation of objects when seen from one point of view.

CONSTRUCTIVE
OR
GEOMETRIC DRAWING.

GEOMETRIC DRAWING.

I. GEOMETRIC DEFINITIONS.

A *line* has length only. There are three classes of lines, —straight, curved and broken. In drawing, a line is the picture of an edge or an outline.

A *straight line* is the shortest distance between two points.

A *curved line* changes its direction at every point.

A *broken line* is made up of short straight lines.

According to their direction lines are classed as vertical, horizontal and oblique.

A *vertical line* is one which extends up and down toward the top and bottom of the page.

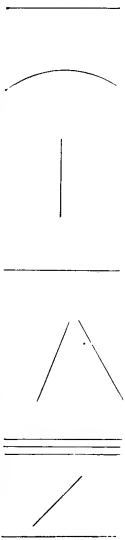
A *horizontal line* is level, *i. e.*, it extends from left to right.

An *oblique line* is one which slants.

In their *relation* to each other lines are classed as *parallel* or *at an angle.*

Parallel lines are those which run side by side and if extended indefinitely would never meet.

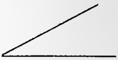
Lines which would meet if extended are *at an angle.*



Lines which would meet at right angles are *perpendicular* to each other. (Note difference between vertical and perpendicular.)

An angle is the difference in direction between two lines.

(An angle is measured by degrees or parts of a circle, and not by length of lines.)



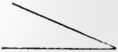
The point of meeting of these lines is called the *vertex* of the angle.

An angle opening 90 degrees, or a quarter of a circle, is a *right angle.*

The lines of a right angle are always perpendicular to each other.

An *obtuse angle* is larger than a right angle, *i. e.*, it has an opening of more than 90 degrees.

An *acute angle* is smaller than a right angle, *i. e.*, it has an opening of less than 90 degrees.



A *plane figure* is one having length and breadth, but no thickness.

Plane figures may be either rectilinear, curvilinear, or mixtilinear.

A *rectilinear figure* is bounded by straight lines.

A *curvilinear figure* is bounded by curved lines.

A *mixtilinear figure* is bounded by both straight and curved lines.

(A semicircle is a mixtilinear figure.)

The sum of the straight lines which bound a figure is the *perimeter* of the figure.

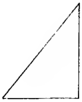
Rectilinear figures are divided according to the number of sides and angles, into three classes, triangles, quadrilaterals, and polygons.

A *triangle* is a plane figure having three sides and three angles.

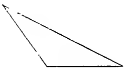
Triangles are classified according to angles and to sides.

According to angles, triangles are divided into three classes: right-angled triangles, obtuse-angled triangles, and acute-angled triangles.

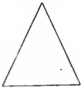
A *right-angled triangle* is one having one right angle.



An *obtuse-angled triangle* is one having one obtuse angle.

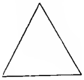


An *acute-angled triangle* is one having all of its angles acute angles.



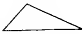
According to sides triangles are classed as equilateral, isosceles, and scalene.

An *equilateral triangle* is one having three equal sides.



An *isosceles triangle* is one having two of its sides equal.

A *scalene triangle* is one no two of whose sides are equal.



All triangles may belong to one class of each division.

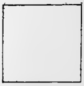
A rectilinear figure having four sides and four angles is

called a *quadrilateral* and its angles may be either right, obtuse or acute.

A quadrilateral having none but right angles and its opposite sides equal, is a *rectangle.*

There are but two rectangles, the square and the oblong.

A *square* is a rectangle having all of its sides equal.



An *oblong* is a rectangle having two of its sides longer than the other two.

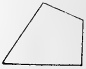
A *parallelogram* is a quadrilateral whose opposite sides are parallel but whose angles may be either right, acute, or obtuse.

Under this head we have the rhombus, or rhomb, and the rhomboid.

The *rhombus*, or *rhomb*, has four equal sides but its angles are not right angles.

The *rhomboid* is an elongated rhomb. It has two acute angles and two obtuse angles, and two of its sides are longer than the other two.

A *trapezium* is a quadrilateral no two of whose sides are parallel.



A *trapezoid* is a quadrilateral having only two of its sides parallel.

Rectilinear figures having more than four sides and four angles are *polygons.* If the sides are equal, they are called *regular*, if unequal, *irregular.*

A *pentagon* is a polygon having five sides and five angles.

A *hexagon* has six sides and six angles.

A *heptagon* has seven sides and seven angles.

An *octagon* has eight sides and eight angles.

A *nonagon* has nine sides and nine angles.

A *decagon* has ten sides and ten angles.

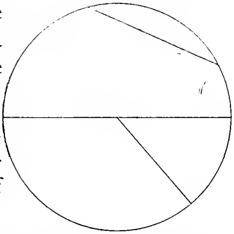
An *undecagon* has eleven sides and eleven angles.

A *dodecagon* has twelve sides and twelve angles.

A *circle* is a plane figure bounded by a curved line every where equally distant from a point within called its center. A circle contains 360 degrees.

The *circumference* is the line which bounds the circle.

The *diameter* of a circle is a line which passes through the center of a circle and touches the circumference in two points.



The *radius* of a circle is a line which passes from the center to the circumference and is always equal to one-half of the diameter.

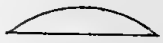
A *chord* is a straight line which cuts the circumference in two points but which does not pass through the center of the circle.

An *arc* is the part of the circumference cut off by the chord.

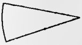
A *semicircle* is the half of a circle. It contains 180 degrees.

A *quadrant* is the quarter of a circle and contains 90 degrees.

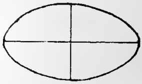
A *segment* is the space bounded by an arc and a chord.



A *sector* is a part of a circle bounded by an arc and two radii of a circle.



An *ellipse* is a plane figure bounded by a regular curve every point in which is at the same combined distance from the foci.



(A circle seen in perspective is an ellipse.)

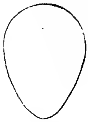
An ellipse has two diameters, a *long diameter* and a *short diameter.*

The *long diameter* is the longest straight line which can be drawn within the ellipse. It is also called the *major axis* of the ellipse.

The *short diameter* is the shortest straight line which will cut the ellipse into two equal parts. It is called the *minor axis.*

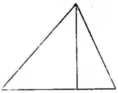
Foci are points in an ellipse from which the curve can be drawn mechanically.

An *oval* is an egg-shaped figure. A semicircle combined with a half-ellipse will produce a very good oval, the radius of the semicircle being one-third of the length of the major axis of the oval.



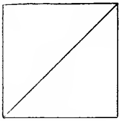
The *base* of a plane figure is the line upon which it rests.

The *apex* is the highest point above the base.

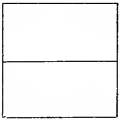


The *altitude* is the perpendicular distance from base to apex.

An *axis* is the straight line on which a body revolves, and it divides it into two equal and similar parts.



The *diagonal* is a line passing through the center and connecting opposite angles.

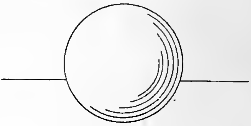


The *diameter* is any line drawn through the center of a figure and extending to the centers of opposite sides.

The center of a plane figure can be found by drawing the diagonals, the point of intersection being the center.

A *solid* is that which has length, breadth and thickness.

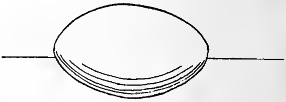
A *sphere* is a solid bounded by one curved surface, every part of which is equally distant from a point within called the center.



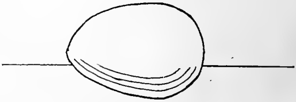
A *hemisphere* is half a sphere.

A *spheroid* is a nearly spherical body formed by the revolution of an ellipse upon one of its axes. If the ellipse is revolved upon its major axis, or long diameter, the *prolate spheroid* is obtained.

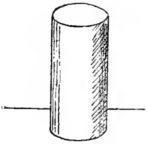
This form of the spheroid is also known as the *long spheroid*, or the *ellipsoid*.



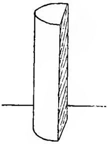
If the ellipse is revolved upon its minor axis or short diameter, the *oblate spheroid* is obtained. This solid is also called the *flat spheroid*.



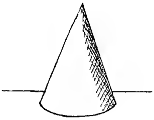
The *ovoid* is an egg-shaped solid.



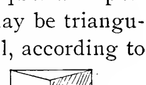
A *cylinder* is a solid of roller-like form whose longest section is oblong and the cross section is circular.



A *half-cylinder* is a solid formed by dividing a cylinder vertically in two equal parts. It has two semicircular ends.

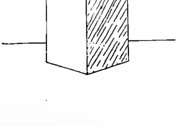


A *cone* is a solid tapering to a point from a circular base.



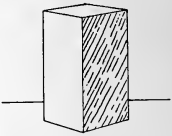
A *cube* is a solid bounded by six equal square faces.

A *prism* is a solid whose ends are similar, equal and parallel, and whose sides are oblong. Prisms may be triangular, square, pentagonal, hexagonal, or octagonal, according to their bases, but they must all have oblong sides.

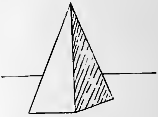


A *triangular prism* is one whose bases are triangles.

There are two triangular prisms, the *rightangled triangular prism*, which is formed by the division of the square prism on one diagonal of the bases, and the *equi-triangular prism*, whose bases are equilateral triangles.



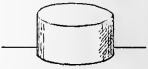
The *square prism* is one whose ends are square.



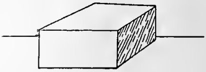
A *pyramid* is a solid having either a triangular, square, or polygonal base, and whose sides are triangles, uniting in a point at the top.

A *square pyramid* is one whose base is square and it has four triangular sides.

A *plinth* is the lowest division of the base of a column. It is a short horizontal section of either a cylinder or a square prism.

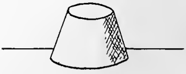


The *circular plinth* is the horizontal section of a cylinder.

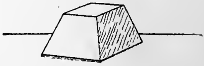


The *square plinth* is the horizontal section of a square prism.

The *frustum* of a solid is the part next the base, formed by cutting off the top parallel to the base.



A *circular frustum* is formed from the cone.



A *square frustum* is formed from the square pyramid.

The *axis* of a *prism* is a straight line connecting the centers of the ends.

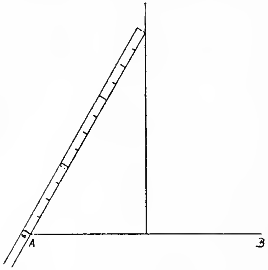
The *axis* of a *pyramid* or *cone* is a straight line connecting the apex with the center of the base.

The *apex* of a pyramid or cone is the highest point above the base.

GEOMETRIC PROBLEMS.

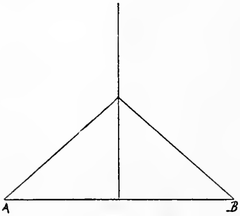
CONSTRUCTION OF SOME SIMPLE PLANE FIGURES WITHOUT THE USE OF COMPASSES.

PROB. 1. *To construct an equilateral triangle.*



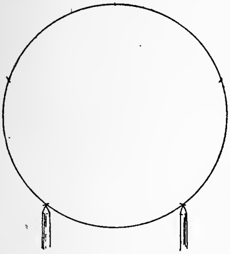
Draw the given base AB, find the center of the base, and draw an indefinite line perpendicular to this point. With the ruler take the exact measure of the base. Place the ruler upon A so that the number indicating the required length shall fall exactly upon this point, then turn the ruler until the end falls upon the indefinite line, taking care that the ruler does not slip from A. The point thus found upon the indefinite perpendicular will be the vertex of the triangle. Prove your work by testing the remaining side and then complete the triangle.

PROB. 2. *To construct an isosceles triangle.*



Draw the base AB, and find the center. Draw an indefinite line perpendicular to the center of the base. On this line measure the given altitude and finish the triangle.

PROB. 3. *To construct a pentagon.*

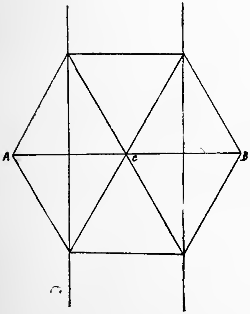


Draw a circle of the required size an ddivide it into five equal parts, by laying off an assumed fifth with two fingers or pencils and then judging of the other four divisions.

Consulting the face of a watch or clock will aid materially in the solution of this problem. Consider the hour to be divided into five portions of twelve minutes each, and the vertex to fall upon XII. Place dots where each division occurs and finish the pentagon by connecting the points.

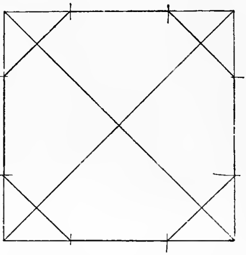
Children may be aided in dividing circles into three or six equal parts, by the use of the clock face.

PROB. 4. *To construct a hexagon.*



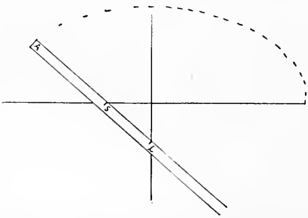
Draw a horizontal AB, equal to the extreme width of the desired figure. Divide AB into four equal parts and name the central division C. Consider AC to be the base of two equilateral triangles, one extending above AC and the second below AC. Proceed to draw as in Prob. 1. Next consider CB to be the base of two similar triangles and construct them. To finish the hexagon join the vertices of the triangles by horizontal lines.

PROB. 5. *To construct an octagon.*



Draw a square of the size of the desired octagon and draw its diagonals. Take the measure of one semi-diagonal and lay off this distance on the sides of the square, measuring from each corner in both directions. Join the points by oblique lines which cut off the corners of the square.

PROB. 6. *To construct an ellipse.*



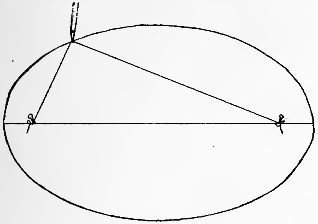
Draw the long and short diameters of the desired length. Use a long narrow strip of paper to obtain points. Mark one end of the paper A. From A mark off one-half the short diameter and name this point S. From A mark off one-half of the long diameter and name this point L. Place this strip of paper on the drawing so that S shall fall somewhere on the long diameter, and L somewhere on the short diameter, and place a mark at A. This is one point in the circumference of the ellipse. Any number of points may be found in the same way.

Through the points found draw the ellipse.

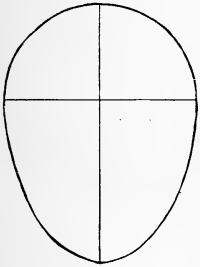
PROB. 7. *Another method of drawing an ellipse.*

Drive two pins firmly into the paper any desired distance apart. Knot a stout thread about the pins letting

the thread be somewhat longer than the distance between the pins. Hold the pencil point firmly against the line keeping it taut all the time and beginning at the left draw the upper half of the ellipse. Beginning again at the left, draw the lower half of the ellipse.



PROB. 7. *To construct an oval.*



Draw a vertical line the length of the desired oval and divide it into three equal parts, through the upper point of division draw a horizontal line two-thirds of the length of the vertical and use this as the base of a semicircle. Upon the lower two-thirds of the vertical construct a half-ellipse using either method given in the two preceding problems.

APPLICATIONS.

Objects based on the square—Book, box, inkstand, envelope, flag.

On the triangle—Bottle, kite, brush, signal flag, sail.

On the circle—Fan, coins, watch, curtain ring, baseball.

On the oblong—Box, book, envelope, house, door, window, picture frame.

On the ellipse—Eye glasses, picture frame, melon, potato.

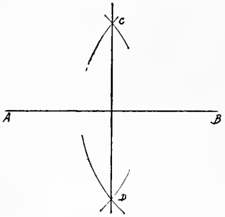
On the oval—Fan, acorn, egg, horseshoe.

On the octagon—Frame of clock face, silk reel.

On the pentagon—Ivy leaf.

TO BE CONSTRUCTED ACCURATELY WITH INSTRUMENTS.

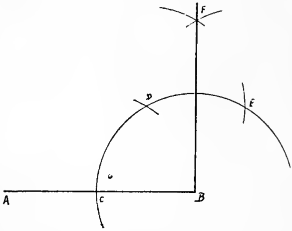
PROB. 1. *To bisect a straight line.*



Draw the given line AB. With a radius of more than half the line and A and B as centers, draw arcs that will intersect both above and below the line in C and D. Join C and D. CD is perpendicular to AB and divides the line AB into two equal parts.

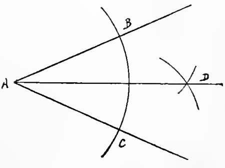
To bisect an arc proceed in the same manner as for a straight line.

PROB. 2. *To erect a perpendicular at the end of a given line.*



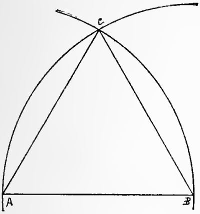
Draw the line AB. With B as a center and any radius draw an arc cutting AB in C. With C as a center and the same radius draw an arc cutting the first arc in D. With D as a center and the same radius cut the same arc in E. With D and E as centers draw arcs intersecting in F. Draw BF which is the perpendicular required.

PROB. 3. *To bisect an angle.*



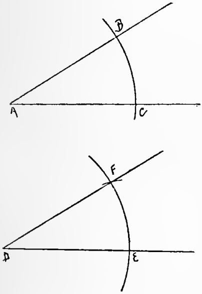
Draw the angle ABC. With A as a center and any radius draw an arc cutting the sides of the angle at B and C. With any radius greater than one-half the arc BC and B and C as centers draw arcs intersecting at D. Draw AD which will bisect the angle.

PROB. 4. *To construct an equilateral triangle on a given base.*



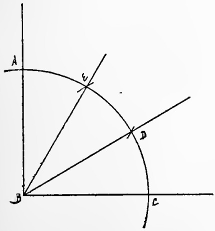
Let AB be the given base. With a radius equal to AB and A and B as centers, draw arcs which will intersect in C. Connect AC and BC. ABC will be the desired triangle.

PROB. 5. *To construct an angle equal to a given angle.*



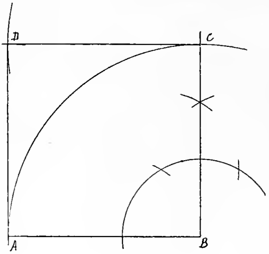
Let BAC be the given angle. Draw any line as DE and take any point in it as D. With A as a center and any radius draw an arc which will cut the sides of the given angle in B and C. With D as a center and the same radius, draw an arc that will cut DE in E. Take a radius equal to BC and with E as a center cut the arc EF in F. Join DF and EDF is the desired angle.

PROB. 6. *To trisect a given right angle.*



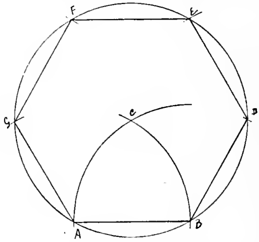
Let ABC be the given right angle. With center B and any radius draw an arc that will cut the sides of the angle in A and C. With the same radius and A as a center cut the arc AC in D. With C as a center and the same radius cut the arc AC in E. Join B and E and B and D.

PROB. 6. *To construct a square on a given base, AB.*



Erect BC perpendicular to B according to Prob. 2. Take a radius equal to AB and with B as center cut BC the same length as AB. With the same radius and A and C as centers draw arcs that will intersect in D. Draw AD and CD.

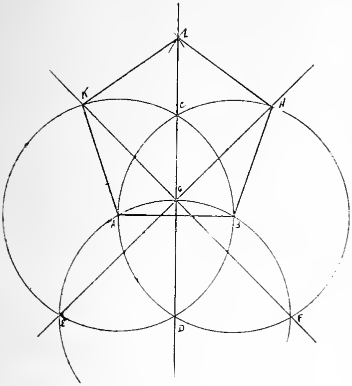
PROB. 8. *To construct a regular hexagon on a given base.*



Let AB be the given base. With a radius equal to AB and A and B as centers draw arcs intersecting in C. With C as a center and the same radius draw a circle passing through A and B. With B as a center and the same radius cut the circle in D. With D. as a center and the same radius cut the circle at E. With E as a center and the same radius cut the circle at F. With F as a center and the same radius cut the circle in G. Join BD, DE, EF, FG, and GA.

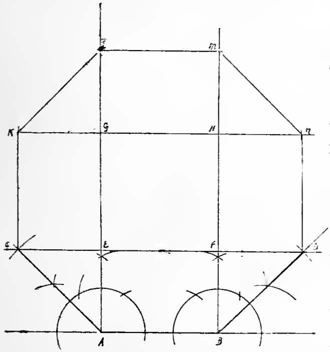
PROB. 9. *To construct a regular pentagon on a given base, AB.*

With a radius equal to AB and A and B as centers draw two circles intersecting in C and D. Join CD. With D as a center and a radius equal to AB draw an arc which



will cut the left circle in E and the right circle in F and the line CD in G. Join E and G and extend the line till it will cut the right circle in H. Join F and G and extend the line till it cuts the left circle in K. With a radius equal to AB and H and K as centers draw arcs that will intersect in L. Draw BH, HL, LK, and KA.

PROB. 19. *To construct a regular octagon on a given base.*



Let AB be the given base. Erect perpendiculars at A and B (Prob. 2) and extend AB indefinitely to the right and left. Bisect the exterior right angles at A and B (Prob. 3). Make the bisecting lines AC and BD equal to AB. Draw the line CD cutting the perpendiculars in E and F. From E and F lay off distances EG and FH equal to AB. Through GH draw an indefinite line. Make GK, GL, HM, and HN each equal to AE or BF. Draw BD, DN, NM, ML, LK, KC, and CA.

WORKING DRAWINGS.

Working drawings are made to assist the artisan in constructing any manufactured object. They are in no sense pictures of the objects, but are simply statements of the *facts* to be considered, that is, they indicate the length, width and height of the object to be made, together with the size and position of all its parts.

In order to show the three dimensions more than one view of the object must be drawn, and the number of the views is limited only by the simplicity or intricacy of the object under consideration, however, three views are usually sufficient to show all necessary facts of simple objects.

The "front view" is usually drawn first, and this view must represent not only the outline of the object, but all the edges that modify the front, and will include everything that can be seen when looking at the object directly in front.

Fig. 1 shows the front view of a cube.

Fig 1.

If the cube had a cylindrical hole through it, it would appear as in Fig. 2.

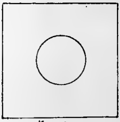


Fig 2

If a cubical inkbottle were represented the neck would appear as in Fig. 3.

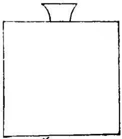


Fig 3

The "top view" will show only what can be seen in looking down upon an object from above and must include everything that can be seen from that point of view.

Fig. 4 represents the top view of a cube.

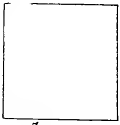


Fig. 4

Fig. 5 shows the top view of a cone.

Pupils often confound the two terms "top" and "top view" and think the point the top view of a cone.

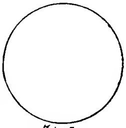


Fig. 5

Fig. 7 shows the top view of the square pyramid.

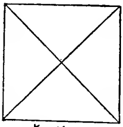


Fig 7

It must be remembered that *wherever there is an edge there must be a line.*

Sometimes an end or side view may also be necessary, and this will include only what can be seen by looking at the object from that side.

If the article is hollow, or there is some interior mechanism, it may be necessary that the interior be shown. This is done by making a "sectional view." The section usually assumes the object to be cut by either a vertical or horizontal plane.

The section is cross-hatched to indicate the cut through the solid portion of the object. Cross-hatching is done by drawing parallel oblique lines about one-eighth of an inch apart across the cut portions. The lines may slant in either direction.

Fig. 6 shows a section of a hollow cylinder.

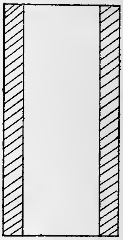


Fig 6.

Sometimes the top view is drawn above the front view and sometimes below it. According to the principles of orthographic projection it should be drawn below the front, but many draughtsmen prefer to give it its own place, and practically, it is of no consequence whether it is placed above or below, if the views are all properly marked so there may be no danger of confusion. It is necessary, however, to have the views stand in such relation to one another, that points may be connected to show their relative position.

There are five kinds of lines used in working drawings.

Dot-and-dash lines are center lines. They are sometimes called construction lines.

Full lines represent visible edges and outlines.

Dashed lines represent invisible edges.

Dotted lines connect views.

Light lines, arrow-points, and figures indicate measurements.

It is not necessary to use center lines unless the object has a curved outline or is difficult to illustrate.

Unseen edges are shown upon corresponding views. This is illustrated in Fig. 7, the working drawing of the spool. It will be seen by examining a spool and comparing it with this working drawing that every fact is clearly told. The hole through the spool does not show when the spool isviewed from the front, but its presence is indicated by dashed lines, which are connected by dotted lines to the top view of the hole which is a small circle. It will easily be seen that this is the only way in which the hole could be shown in its true length except by a sectional view. It will also be noticed that the circle representing the shape of the "shank" of the spool is indicated in the same way upon the top view.

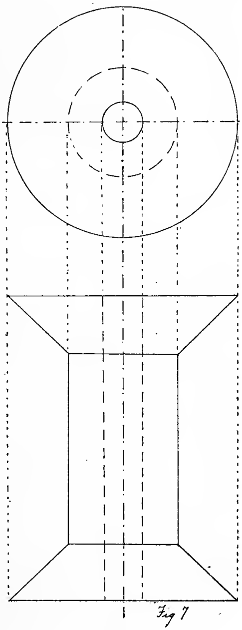
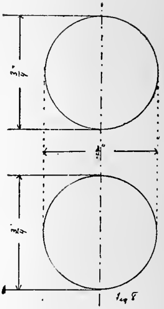


Fig 7



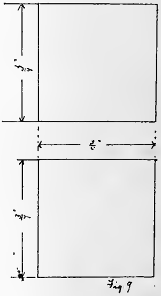


Fig. 8 gives the working drawing of the sphere and the necessary measurements.

All measurements should be carefully placed on the drawing. The arrow-points are to be made freehand and must indicate the entire length of the distance measured. This must frequently be indicated by "extension" lines as shown in Fig. 8. The measurement lines must have a little space left in the center for the figures.

The figures must always read from left to right, and from top to bottom. The opening of the arrow-heads must be toward the figures.

Two small dashes placed at the upper right corner of the figure indicate inches, thus, 7″ is read "seven inches."

One small dash in the same position indicates feet, thus, 6′ is read "six feet."

6′ 7″ means "six feet and seven inches."

The top view or the bottom view is often called the "plan."

The side view or the front view is known as the "elevation."

Architects always use the terms "plan" and "elevation."

Fig. 9 shows a working drawing of a cube. Notice that here as in Fig. 8 the measure of the width is placed between the two veiws as it is a measure common to both of them, and it is best to show measurements in as few places as possible.

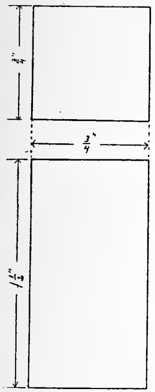


Fig 10.

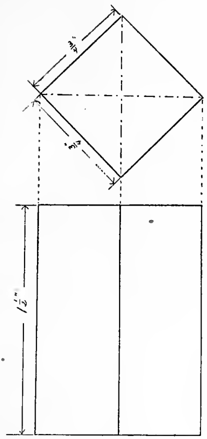


Fig 11.

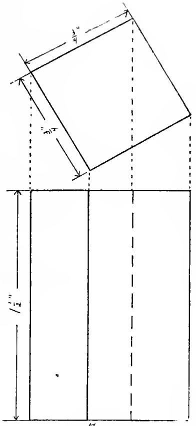


Fig 12.

Fig. 10 is the working drawing of a square prism, using one of the oblong faces as the front.

Fig. 11 shows a working drawing of a square prism turned at an angle of 45 degrees. Notice that the measures in the top view are placed upon the oblique edges these being the true measures of the prism, but the width of the oblongs is not given as this can be determined only by the diagonal of the top.

Fig. 12 is a working drawing of the square prism when placed at an angle of 30 degrees to the right. It will be observed that the farther corner of the top does not coincide with the nearer angle, and if the prism were transparent, the back edge would be seen, it is therefore indicated by dashed lines.

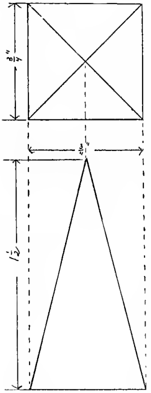


Fig 13.

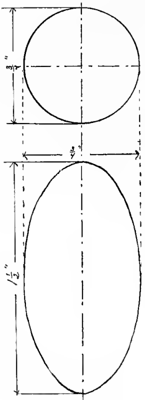


Fig 14.

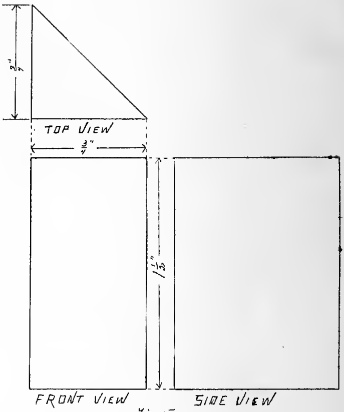


Fig 15

Fig. 13 is a working drawing of the square pyramid. Notice the manner of indicating the measure of the altitude of the triangle. It is well to put most measurements outside of the drawing and, wherever possible, to the left of the drawing.

Fig. 14 is the working drawing of the ellipsoid.

In giving measurements of circles the diameter should always be given and not the radius.

Fig. 15 is the working drawing of a right-angled triangular prism. Notice that the length of the front and side views is indicated by a measurement placed between the two, and that the width of the side view is not indicated, because it is determined by the hypothenuse of the top view.

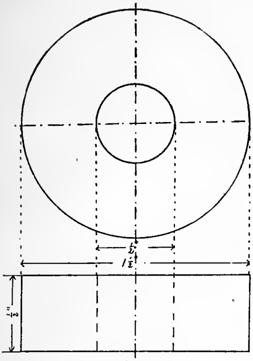


Fig 16

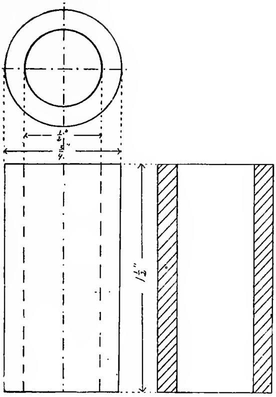


Fig 17

Fig. 16 is a working drawing of a washer. In fractional measurements the fractions should always be reduced to the lowest terms and the dividing line of the fraction should be horizontal rather than oblique, thus, "one-half" should be written $\frac{1}{2}$ not 1/2.

Fig. 17 shows the working drawing of a hollow cylinder with a sectional view.

Working drawings should first be drawn freehand, and afterwards from the freehand sketch an accurate drawing be made, using all necessary instruments both for drawing and measuring.

DEFINITIONS OF TERMS USED.

A *working drawing* is a drawing from which an object may be accurately constructed.

Front Elevation—What can be seen when the front alone is observed. Front view.

Side Elevation—What can be seen when one side is observed by itself. Side view.

Plan—What can be seen when looking directly down upon the object. Top view.

Sectional View—The representation of an object as it would appear if cut through by an intersecting plane.

DEVELOPMENT.

The tinsmith, the shoemaker, the glovemaker, and many other craftsmen, must use patterns in their work, the pattern being a drawing of the entire surface of the object, which, if folded together, and fastened, would form a complete model of the object.

These patterns are called *developments* or *flats*.

It is absolutely necessary that a development should be of accurate size and that the parts should be correctly adjusted, in order to match when folded together, therefore all work in the flat must be done with a ruler and carefully measured.

The development must be drawn with clear bright lines, and the laps for fastening, with light lines.

Laps should not be placed on the top or base but on the sides of the object. They should be about ¼″ in width, and carefully bevelled at the corners so they will not interfere with each other when the object is folded together.

Fig. 1 shows the development of the cube.

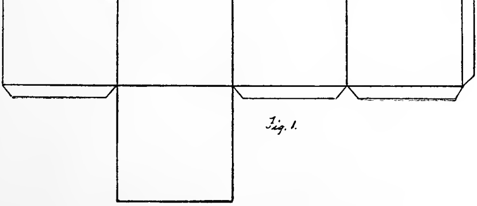


Fig. 1.

Fig. 2 is the development of the square prism.

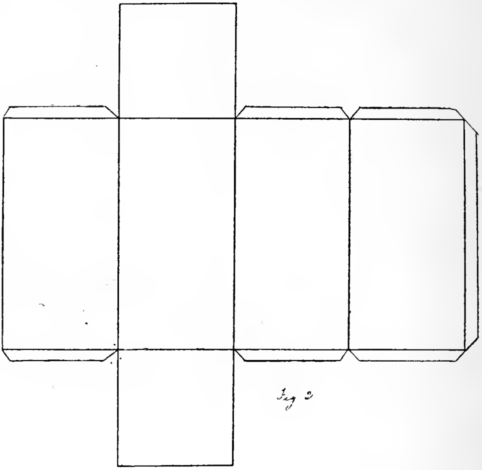


Fig 2

Fig. 3 shows the development of the square plinth.

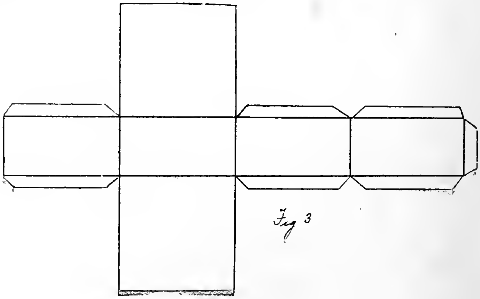


Fig 3

Fig. 4 shows the development of the triangular prism.

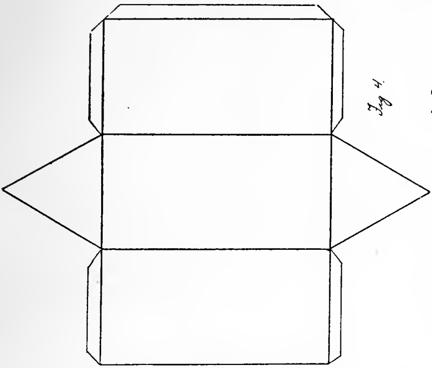


Fig 4.

By experimenting a little with the development of these simple geometric solids it will be seen that many pretty and convenient articles may be constructed by slight changes in these fundamental developments. Boxes of various shapes, card cases, match safes, and many other pretty little articles can be easily made.

Fig. 5 is the development of the square pyramid.

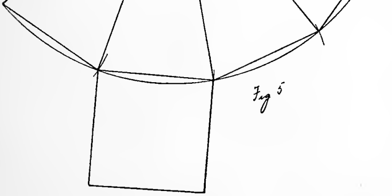


Fig 5

To draw this development take a radius equal to one of the long sides of a triangular face of a pyramid and draw an indefinite arc using A as a center. Join A and B. Take a a radius equal to one side of the base and with B as a center cut the arc in C. With C as a center and the same radius cut the arc in D. With D as a center cut the arc in E.

With E as a center cut the arc in F. Join AC, AB, AD, AE, and AF. Draw the chords to the arcs BC, CD, DE, and EF. On the side CD draw the base of the pyramid.

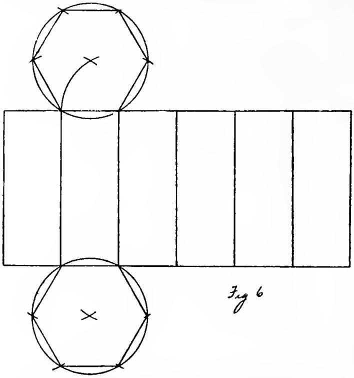
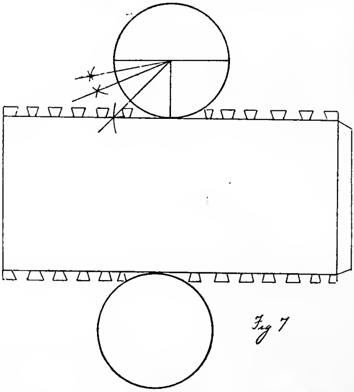


Fig. 6 is the development of the hexagonal prism.

A knowledge of the geometric problems given in another part of this book will be of great assistance in working out many of the more intricate developments, in fact, it would hardly be possible to do the work with any degree of accuracy without them.

Fig. 7 shows the development of the cylinder.



In the development of objects having circular faces like the cylinder, cone, etc., the approximate length of the strip for the side may be gained by multiplying the diameter of the circular face by 3.1416, but if accurate work is desired resort must be had to the compasses.

With the aid of the compasses draw a circle the

size of the end of the desired cylinder. Quadrisect the circle, bisect one of the quadrants, bisect one of the half-quadrants, and then bisect one of the last divisions. Draw the chord to the last arc and it will be very nearly 1-32 of the entire circumference. If the circle is a very large one it would be well to subdivide still farther, but for a 2″ circle the variation between the chord and the arc of 1-32 will be too small to affect the accuracy of the work when finished.

Laps for objects having curved surfaces should be wedge-shaped, and separated far enough so they will not overlap.

The development should be usually made from a working drawing, so that the working out of geometric problems may appear in the drawing but not in the development.

ALPHABET.

The alphabet given below is peculiarly adapted to mechanical drawing as the letters are made up entirely of straight lines and therefore the letters may all be made with a ruler if desired.

DECORATIVE DRAWING

OR

ORNAMENT.

BOTANICAL DRAWING.

Botanical Drawing includes all study of plant form, and must precede all work in design except that of the simplest form, *i. e.*, designs composed of geometric forms.

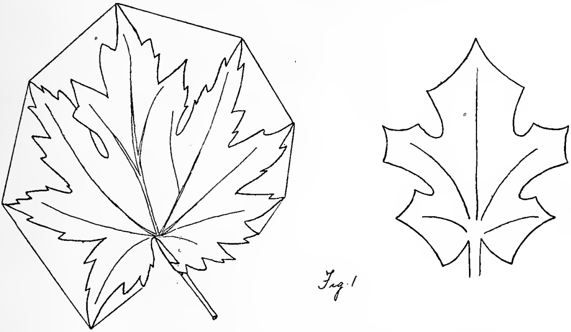


Fig. 1

The drawing of entire edged leaves comes first in this work and after this, the drawing of serrated leaves, and finally lobed and compound leaves. Mnch interesting work may be done in the drawing of pods, acorns, peanuts, beans, peas, corn, etc.

In leaf drawing consider the slant, general curve and length of the midrib and draw it, then determine the width of the leaf. If the leaf is a simple one it can be drawn directly, if it is lobed it should be "blocked in," *i. e.*, the general masses outlined and then the details of form drawn, (Fig. 1.) Avoid drawing too many of the small veins, only enough of them being drawn to indicate the general growth.

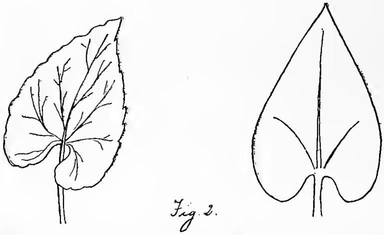


Fig. 2.

Good form and delicacy of treatment are essentials.

In drawing sprays of leaves close attention must be paid to the growth of the leaves upon the stem, whether opposite, alternate, whorled or perfoliate.

All peculiarities of growth must be carefully noted and especially the placing of the leaf upon the stem.

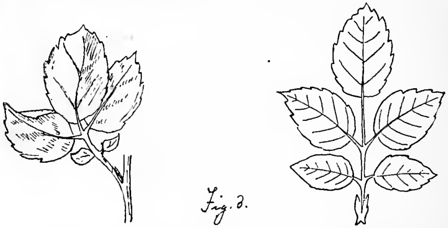


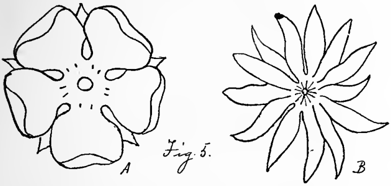
Fig. 3.

Make your leaves *grow* from the stem, do not make them look as if glued on.

In the study of flowers choose for the first attempts very simple ones, as the wild rose, buttercup or apple blossom.

Fig. 4.

Draw them full face view and notice carefully the placing of the petals, whether overlapping, or not. Some flowers are easily drawn if studied from a side view, and under this head we find the violet and tulip.



For the purposes of decoration, it becomes necessary, that foliage and flower forms shall be shorn of their imperfections, and that unimportant details shall be either omitted or simplified; this change in form is known as *conventionalization*, a conventional leaf being a modified form of the natural leaf that will adapt it to ornamental purposes. Figs. 1, 2, and 3 are examples of natural leaves and their conventionalizations. For borders, vines may be made conventional, for rosettes, flower forms like the wild rose and daisy. Fig. 5.

DESIGN.

Ornamental design applies to the whole subject of decoration, and we must do as all nations before us have done—go to nature for our laws and principles.

The principle which the child can most easily grasp is *repetition.* Anything which is repeated regularly, and at intervals, becomes pleasing to the eye, as intending design. Circles, squares, and other geometric figures, repeated regularly, form a pleasing border, and among the first ornaments of savage tribes were rows of shells, and we find the uncivilized races of today wearing strings of animals teeth, and with their dress decorated in angles to represent them. Fig. 1.

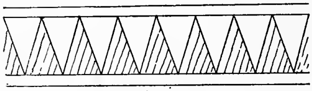


Fig 1

Even a straight line becomes ornamental when repeated and is often used as a decoration for the dress of today.

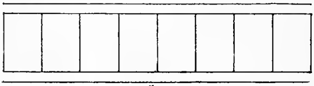


Fig. 2

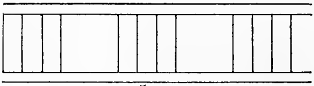


Fig 3

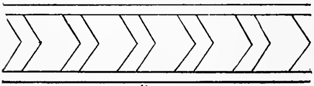


Fig 4

We get from the ancients many examples of simple repetition of lines, and it is possible that this was first suggested by reed plaiting. Figs. 2, 3, and 4 are borders from Egyptian costumes.

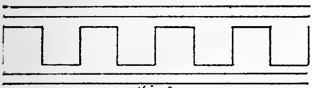


Fig 5

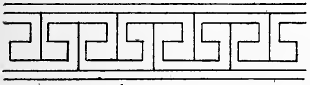


Fig. 6.

Fig. 5 is a Greek fret, and Fig. 6 is from the Chinese.

Geometric figures were often used in ancient ornament.

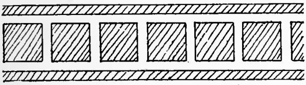


Fig. 7

Fig. 7 is an example of simple repetition taken from an Egyptian tomb.

The next principle to be considered is *alternation.* Under this head we have four points to consider, alternation of position, of form, of size, and of color. *Alternation* of *position* may have been first suggested by the accidental misplacement of the unit of design. Fig. 5, given above, is a good example of this principle in the fret.

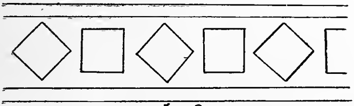


Fig. 8

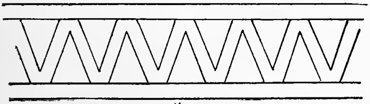


Fig. 9

Figs. 8 and 9 are also simple illustrations of this principle.

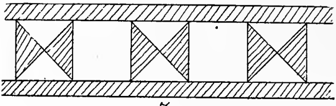


Fig. 10.

Fig. 10 is taken from Byzantine jewel work.

Alternation of *form* is illustrated in Figs. 11, 12, and 13.

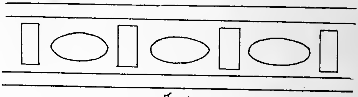


Fig. 11.

Fig. 11 is taken from a Greek vase.

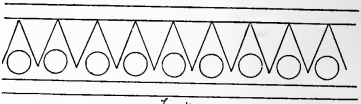


Fig. 12.

Fig. 12 from an Egyptian tomb.

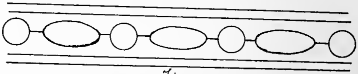


Fig. 13.

Fig. 13 is the Greek astragal or bead moulding.

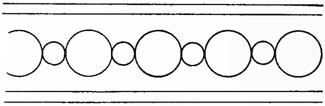


Fig. 14

Alternation of *size* is shown in Figs. 14 and 15.

Fig. 14 is a form of the Greek guilloche.

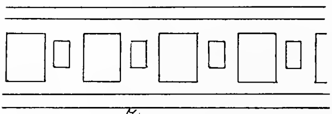


Fig. 15.

Fig. 15 is an example of Byzantine jewel work.

Great care must be taken in working out the next step, that of *alternation* of *color*. Until color has been made a

study, designs should be worked out very cautiously and it is best that but one color should be taken, making a tint alternate with a shade, a tint with the standard, or a shade with the standard.

The principles which apply to borders are equally applicable to radial arrangements or growth from a center. This form of ornament is also known as the *rosette.* As we get the idea of the border from the vine, so we receive the idea of radiation around a center from the flower, whose petals, sepals and stamens, all follow a regular arrangement about a center. (See Fig. 5 under Botanical Drawing.)

Simple but beautiful examples of this, are found in the trefoil and quarterfoil. Figs. 16 and 17 are radial arrangements enclosed in the square.

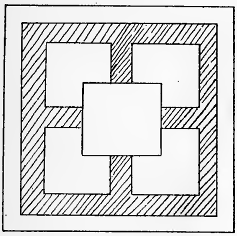


Fig. 16.

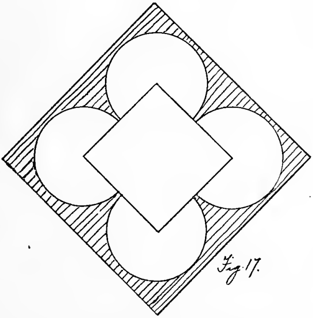
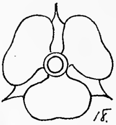


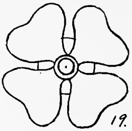
Fig. 17.

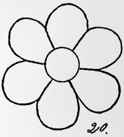
Radial arrangements must always have centers which will hold the radiating units firmly together, *strength* being one of the underlying principles of correct design.

Radial arrangements may consist of any number of units,

and the enclosing form may be any geometric figure, from a triangle to a circle. See Figs. 18, 19, and 20,







This principle of *radiation* may be carried still further and the design radiate from a point, from a vertical line, or from a horizontal line. The Greek anthemion illustrates radiation from a point. The growth of leaves from the parent stem illustrates radiation from a line. Of *symmetry* in design, Leland says, "Any design, however meaningless or irregular, becomes symmetrical as a part when it is accurately repeated in union with itself." Ward in his "Principles of Ornament" says, "The most unshapen or ragged blot, if exactly reproduced on the opposite side of a straight line will make ornament, and at the same time illustrate symmetry."

The law of *fitness* or *adaptation* is by many writers placed as the primary principle of design, and it is that quality which makes the design in every particular adapted to the purpose for which it is used, and if added to or changed in any way would detract from its beauty.

Contrast can be obtained both in form and color. We find examples of contrast of form in Figs. 11, 12, and 13.

Repose is that quality in design that makes it restful to the eye. A wall paper that keeps the eye wandering from one part of the pattern to another, lacks this vital principle.

A surface pattern is any design that repeats itself in the four directions. Under this head we have designs for wall

paper, oil-cloth, textile fabrics, etc. The simplest surface patterns are made by repeating geometric units at regular intervals.

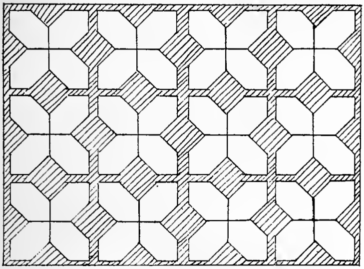


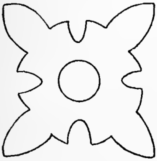
Fig. 21

Figure 21 is a simple illustration of the surface pattern.

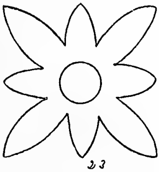
For use in borders and surface patterns, the simple geometric units may be modified by changes in the outline of the figure without altering the general shape.

By covering the "field" in such a way that the interstices also form pleasing shapes, very beautiful designs are obtained.

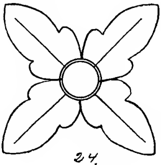
Figs. 22, 23, and 24 are examples of *modified squares.* Fig. 23 is a Gothic unit. Fig. 24 is an example of Japanese enamel.



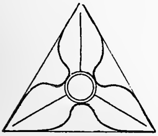
22



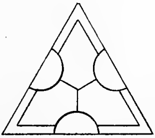
23



24



25



26.

Figs. 25 and 26 are examples of modified triangles.

Modified circles are frequently based on flower forms and an example is seen in Fig. 5, Botanical Drawing.

In all design it is necessary that due attention be paid to the *distribution* of the units, *i. e.*, they must be evenly placed on the surface to be covered, and they must be of such proportionate size of the entire field, that at least one-fourth of it is left uncovered. In surface patterns, the design should be so drawn that if the paper were rolled like a cylinder the pattern would match at the edges. This should be true of both directions. Sometimes, to add force and brilliancy to a design, it is necessary to half-tint the field or background, this will also add repose to the design by showing at once what the unit is, which the designer had in mind.

Half-tinting is produced by drawing light fine parallel lines across all portions of the field uncovered by the design. Usually oblique lines are used, but this is not arbitrary. These lines should always keep the same direction over the field and never seem to radiate from the center.

HISTORIC ORNAMENT.

Historic Ornament embraces the ornament of the various nations from the earliest times.

By reason of distinguishing characteristics, Historic Ornament is usually divided into six schools or classes, Egyptian, Grecian, Roman, Byzantine, Saracenic and Gothic. The three former belonging to the period of ancient history, and the three latter to that of medieval history.

From the very earliest period of ornamental art, people have gone to nature for suggestions for decorative design, and from nature they have received the laws of their application.

Now while all nations have gone to nature for their art, they have at the same time *conventionalized* all nature, that is, they have applied only the general laws of nature, and each nation has had its own individuality in its treatment of nature. This individuality has given rise to the different schools of art and it has been modified by religion, state of refinement, and intercourse with other nations.

Naturally, we find the simplest forms in the earlier days of art, for each nation has drawn from and added to its predecessor. We can easily recognize where the Greeks drew from the Egyptians, the Romans from the Greeks, and all succeeding art from all of these. In the ancient schools the Egyptian was mainly a symbolic art, while the Greek and Roman were purely aesthetic.

The most important symbols in Egyptian art are the wave scroll of the Nile, the lotus, the papyrus, the winged globe, the asp, the fret, the beetle, and the cartouche containing hieroglyphics.

The lotus, or water lily of the Nile, was the type of the inundation of that river, from which it obtained its fruitfulness. The Egyptian priests taught that a god dwelt in the lotus, and the more it was worshiped the more plentiful the harvest would be. The flower made its appearance just as the grain was coming out of the ground, and if large numbers of loti were seen, the people believed they were to have a plentiful harvest.

The lotus when used in ornament, signified food for the body. Fig. 1 shows the natural and the conventional lotus flower.

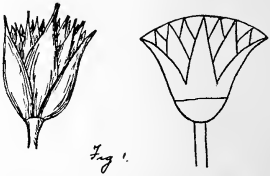


Fig. 1.

The zig-zag or wave scroll of the Nile appeared very frequently. In its simplest form, it is composed of straight lines (Fig. 2) and is called the zig-zag. In its later form it is formed from the spiral (Fig. 3).

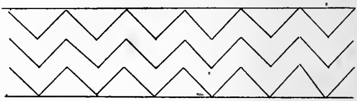


Fig. 2

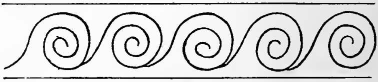


Fig. 3.

The papyrus grew in large triangular groves on the banks of the Nile, the apex of the triangle pointing towards the

water. This peculiar growth, aided by the triangular shape of the blade, assisted it to withstand the great force of the current of the river. In the earliest times these plants were gathered, dried in the sun, and bound in great masses with cords and used for the construction of the people's huts. When architecture became a study they gave the conventional treatment of this plant an important place. It was the type of the column with its capital, the flowers forming the capital, the stalks the column, the roots the enrichment of the base. These columns were arranged in long rows to typify the natural grove. The papyrus symbolized food for the mind.

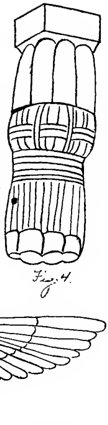


Fig. 4.

Often the column was covered with hieroglyphics, sometimes in vertical and sometimes in horizontal rows.

Fig. 4 shows the capital from a small column from the Temple of Luxor, dating 1250 B. C. It represents eight buds of the papyrus bound together.

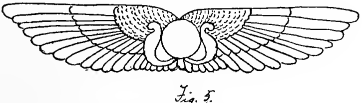


Fig. 5.

The winged globe (Fig. 5) was a talisman of good luck. The globe represents the sun, the wings, Providence, and the two asps, power or monarchy. It was invariably placed over doors or windows, or in passages, and was sometimes of great size.

The fret, shown in Fig. 6, is a symbol of Lake Moeris

with its twelve palaces and three thousand chambers, which typified the twelve signs of the zodiac and the three thousand years of transmigration which the wandering spirit was to undergo.

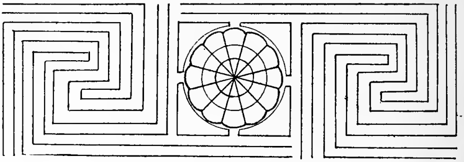
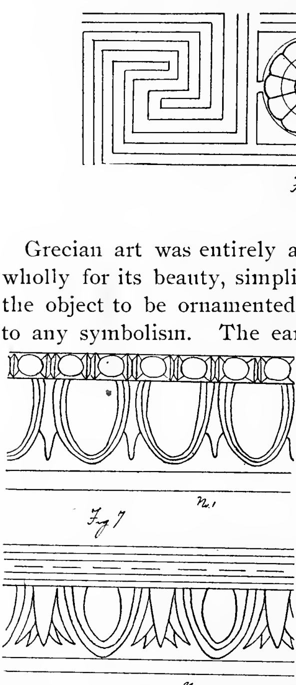


Fig. 6.

Grecian art was entirely aesthetic, that is, it was chosen wholly for its beauty, simplicity of form and adaptation to the object to be ornamented, and utterly without reference to any symbolism. The early period of Greek ornament was characterized by the echinus, the anthemion, the fret and the astragal. The echinus, sometimes called the "egg and tongue" moulding, was probably suggested by the Egyptian moulding containing the oval and the pendant lotus.



No. 1

Fig. 7

No. 2

No. 1, Fig. 7, is the Grecian form, and No. 2, Fig. 7, is the Egyptian.

Fig. 8 is an illustration of the fret, many varieties of which were used.

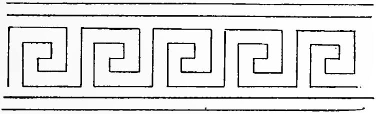


Fig. 8

The Romans in their art merely elaborated Greek ornament. The only important element which they introduced was the arch, and while the Greeks used the scroll and the acanthus to a very limited extent, the Romans made them powerful factors in their ornamentation.

The use of the arch opened a new field of architecture and this combined with the art of vaulting, which they learned from the Etruscans, enabled them to cover in large spaces which the Greeks could not do.

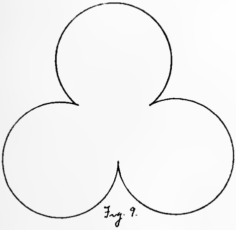


Fig. 9.

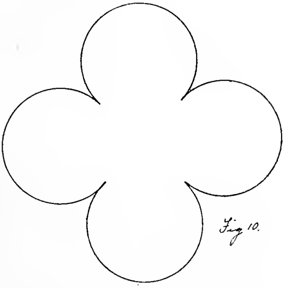


Fig. 10.

The Byzantine was the first Christian school of art and it was largely symbolic. Both in this school and the Gothic, geometric forms played an important part in design, for it

was by these forms that they sought to teach the doctrines of the Christian faith. The circle symbolized eternity. Three interlaced circles, or the trefoil, (Fig. 9) signified the equality and the eternity of the Trinity, the quarterfoil, (Fig. 10) typified the four Evangelists.

The serpent figures largely as symbolic of the Fall of Man. The cross occurs in almost all decoration and the cross is sometimes composed of five circles, the one in the center meaning the Lord, and the four outer ones forming the quarterfoil and referring to the four Evangelists.

COLOR.

The teacher who wishes to make a study, however slight, of color, should provide herself with a glass prism of some sort. A glass lamp pendant or paper weight will do if nothing else can be had, for no satisfactory work can be done until something is at hand whereby the colors of the spectrum can be obtained.

It will first be noticed that red appears at the bottom of the spectrum but it is usually the first color studied, because more familiar than violet which appears at the other end. The spectrum colors are six in number, red, orange, yellow, green, blue, and violet. The spectrum colors are also called the *standard* colors.

Some writers have in past times given seven colors as the number, putting indigo between blue and violet, but modern scientists consider indigo as a mixture of blue and violet and drop it from the list.

Interspersed with the standard colors there are innumerable hues, or mixtures of these colors, and by studying the hues, we get a prism of eighteen tones, namely:

Red,	Green,
Orange Red,	Blue Green,
Red Orange,	Green Blue,
Orange,	Blue,
Yellow Orange,	Violet Blue,
Orange Yellow,	Blue Violet,
Yellow,	Violet,
Green Yellow,	Red Violet,
Yellow Green,	Violet Red.

The last hue, violet red, properly belongs to the beginning of the spectrum.

A little thought will show how this spectrum has been selected, that is, if a little orange is mixed with a large proportion of red, we still have red, though it is no longer pure red but a hue of red, orange red.

All the intermediate tones are composed in the same way.

A mixture of two colors produces a hue, and a glance at the name of the hue will give the predominating color, as well as the name of the one united with it. A sample book of colored papers such as may be had of dealers in art supplies for schools will be of great help at this point. By a little practice with these papers, some valuable facts may be ascertained. Take a piece of colored paper, some one of the standards is preferred, and hold it first in a strong light and then in a feeble light and note the changes which occur. It will at once be seen that the *strength*, or *value*, of a color changes in direct proportion to the brilliancy of the light it is subjected to.

Red will vary from pink to brown, and these changes in a color according to the amount of light received are called its *tones*, and these tones in regular order from the lightest tone, or brightest illumination, to the darkest, or entire absence of light, form a *color scale.*

By mixing light, or in pigments, white, with a standard color, we obtain a *tint* of the color.

By absence of light, or by mixing black with a standard, we obtain a *shade* of the color.

Five tones will be sufficient for the ordinary scale which

will be formed as follows: 1. Lightest tint; 2. Second tint; 3. Standard color; 4. First shade; 5. Darkest shade.

The first three colors in the spectrum, red, orange and yellow, are often spoken of as *warm* colors, and the last three, green, blue and violet, as *cold* colors.

Two colors which when mixed will produce gray are *complementary* to each other.

The following are some of the pairs of complementary colors:

Red—Blue-green.	Green—Violet-red.
Orange—Green-blue.	Blue—Orange-yellow.
Yellow—Violet-blue.	Violet—Green-yellow.

While it is usually considered that complementary colors are harmonious, the colors should not be used in their full strength as this produces too harsh a combination to be pleasing. It is well to combine a tint of one with a shade of the other, or tints or shades of one with the standard of the other.

Two colors are said to be *harmonious*, if when placed side by side they form a pleasing whole.

The simplest harmony is called *dominant harmony*, and is composed of different tones of the same scale. Another harmony which may be classed under the same head is the combination of black, white and gray.

Analogons harmony is produced by the combination of tones from neighboring scales.

Complementary harmony is produced by the combination of colors which when mingled produce white.

The *harmony* of *contrast* is produced by the use of a color with black, white or gray.

Owen Jones in his "Grammar of Ornament" gives some general principles concerning colors, which are appended:

1. Color is used to assist in the development of form, and to distinguish objects, or parts of objects from one another.

2. Color is used to assist light and shade, helping the undulations of form by the proper distribution of the several colors.

3. When two tones of the same color are juxtaposed the light color will appear lighter, and the dark color, darker.

4. When two different colors are juxtaposed, they receive a double modification; first, as to their tone, (the light color appearing lighter, and the dark color appearing darker): secondly, as to their hue; each will become tinged with the complementary color of the other.

5. Colors on white grounds appear darker, on black grounds, lighter.

PICTORIAL DRAWING

OR

REPRESENTATION.

REPRESENTATIVE OR PICTORIAL DRAWING.

In pictorial drawing all objects are drawn simply as they appear, and not as they really are, that is, we do not draw the parts of an object in their true proportion one to another, but only in the proportion which they *appear* to bear to one another. As a consequence of this we cannot take measurements with a ruler as we do in mechanical drawing but we must depend very largely on the accuracy of our eye in finding apparent proportional measurements.

But until we have trained our eye, by long and careful work, we must have other aid, and this help comes to us by means of the pencil.

First determine the part of the object which is seen most nearly in its true size. Use this edge as the standard by which to measure other edges.

Let the pencil be held with the fingers, leaving the thumb free to mark distances on the pencil. For measuring take care to use the top of the pencil, and not the point, and it must be held at *arm's length* so that there may be no change of radius.

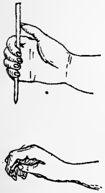


Fig. 1.

For level distances the pencil must be held exactly horizontal, for all vertical measurements it must be held perpendicular to the floor. When the measurement of the nearest edge is gained, compare all others with it.

For retreating distances like the top of the cube in front

of and below the eye, hold the pencil in a vertical position, let the top of the pencil coincide with the farthest edge, place the thumb at the point on the pencil where the nearest edge seems to come and without changing the position of the thumb move the arm, till this apparent distance can be compared with the apparent height of the edge which is to be considered as a standard of measurement.

It will be well to practice at first on large forms or plane figures, like the panels of a door or the panes of glass in a window. For practice at first, place yourself directly in front of the object to be measured and then verify the proportions gained by means of a ruler. Draw large quadrilaterals upon the blackboard or cut them from paper and pin upon the wall and measure proportions. When you have accustomed yourself to the use of the pencil for these measurements and feel that you can judge them accurately, change your sitting position to the left or right of the object, so that you will see it obliquely, and take measurements again, and notice how the figure apparently diminishes in width horizontally. View the same object from all possible points and note results. The time spent in this way will be of great advantage in training the eye to see correctly.

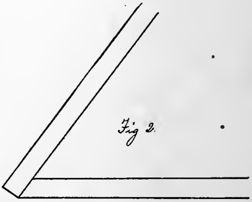


Fig 2.

For measuring angles two narrow strips of board, cardboard, or paper may be used. If paper is used it must consist of several thicknesses in order to give it sufficient stiffness not to bend. Hold one end of each strip between the thumb and forefinger. Move the hand till one strip is brought into position to coincide with one side of the

angle to be measured and then move the other strip till it is coincident with the other side of the angle. The strips of paper open like a pocket knife. (See Fig. 2.)

In drawing objects begin with the simplest forms and with those that will present but small difficulties of perspective. Fasten a palmleaf fan upon the wall in front of you and study its outline and radiation of veining, and draw. Change its position to an oblique one and try again. Draw it in every way in which you will get its outline in nearly its true shape. Notice any little defects in the fan, a broken edge, a loose thread, etc., and try to represent them.

Avoid hard, smooth outlines and endeavor to make your work look artistic.

An artist's palette, a handglass, a watchcase, all make excellent subjects for the beginner to study.

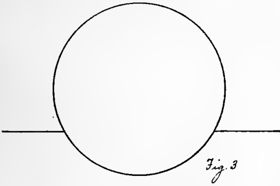


Fig. 3

The sphere is the simplest object that can be studied as its outline remains always the same in whatever position it may be placed. (Fig. 3.)

Find the highest point on the sphere and notice that when the sphere is below the eye we see beyond the highest point. In drawing the simple outline of the sphere place a mark to indicate the highest point on its surface.

It is better to draw the outline of the sphere without any guide-lines whatever and when it appears to you to be correctly drawn, test with the pencil and rectify all inaccuracies. If drawn without the use of diameters the danger of flattening the quarters is much lessened, the student is not ham-

pered by the fear of being unable to hit the points, and the sphere may be studied as a whole rather than in parts.

After the sphere has been studied carefully the straight line solids may be considered.

To study convergence, stand in front of a row of desks at a little distance from them and with a long stick held at arm's length between the eye and the desk, measure the apparent length of the front desk from left to right, and compare with the length of the rear desk. Measure the aisles in the same way. Measure the front edge of the desk nearest you and compare with the back edge of the same desk. Do the same to other desks at different distances from you. Place a book upon the table and notice convergence in the same way. Next observe a sheet of paper laid upon the table.

Be careful at this point that the object to be measured is directly in front of and below the eye.

In taking all proportional measurements it is well to close one eye.

Note the convergence of railroad tracks, of lines of telegraph or telephone poles, of the streets on which you walk. Keep your eyes and mind open for convergence in all that you see, until you have accustomed yourself to make a mental note of it, almost unconsciously to yourself.

Place a cube on the desk directly in front of and below the eye, and note the number of sides seen. Draw the front as seen, which will be a square, then take accurate measurements of the apparent width of the top from front to rear and compare with the height of the front. Measure the back edge of the top and compare with the front edge and it will be found to appear much shorter, and the two side lines will

converge till they are cut by this shorter line. As the cube has been placed directly in front of the observer the two retreating lines must recede at equal rate, and the two angles formed by the meeting of the sides with the rear line will be equal, and the two lines, if continued, will meet in a point directly above the center of the drawing. The point at which these lines meet is called the Point of Sight and the horizontal line drawn through the Point of Sight is called the Horizon Line.

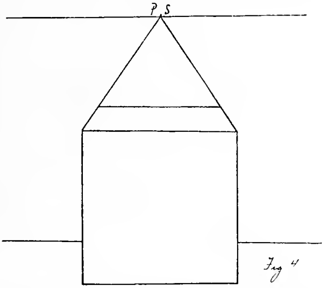


Fig 4

The Horizon Line is assumed to be on the level of the eye and to be the line which bounds the sight in the distance. The space in which the object is represented is called the Picture Plane and is supposed to include only so much as the observer can see without altering the position of the head,—an angle of about sixty degrees.

The extremities of the horizon line are called Distance Points as they are assumed to mark the limit of the sight to right and left. The point of sight will, of course, be a point between these two points.

Place the cube in the same relative position to you as before but so that the back edge of the table on which it rests appears to be about one-third of the height of the cube above the lower edge. Draw this line and call it the *table-line.* (See Fig. 4.)

When teaching this point to your class see that the pupils

understand clearly the meaning of this line. A little girl, one day, on being questioned as to its meaning, said it was "a handle."

Take great care that the table line shall be level.

When the cube has been carefully studied in this way place a box in the same position and draw, noting all the differences between the box and the cube. (Fig. 5.)

Next study the drawing of a book, first placed on end, and then lying on its side. (Figs. 6 and 7.)

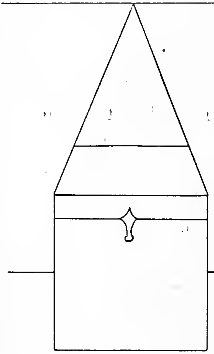


Fig 5

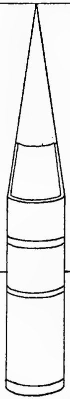


Fig 6

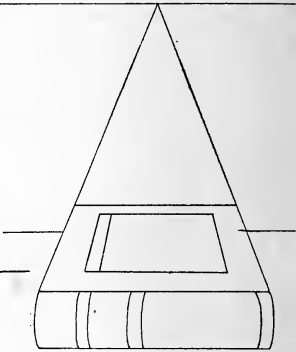


Fig. 7.

Study the cube placed a little to the left, and the center of the front on a level with the eye. It will be noticed that the upper half of the cube is above the horizon line and that the lower half is below the line, but that the retreating edges still meet in the point of sight, and therefore the upper re-

treating edge slants downward, while the lower edge runs upward to the same point. (Fig. 8.)

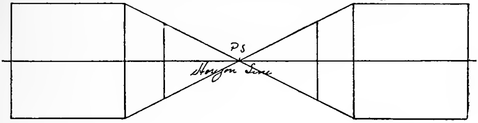


Fig 8 Fig 9

Draw a cube as if placed with its center on the level of the eye and to the right of the observer (Fig. 9.)

Represent a hollow box in the same position having the opening on the front (Fig. 10.)

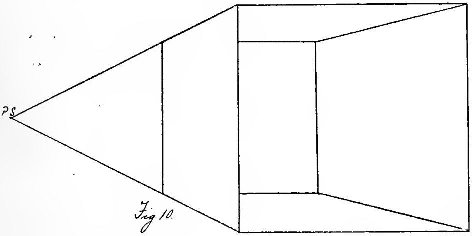


Fig 10.

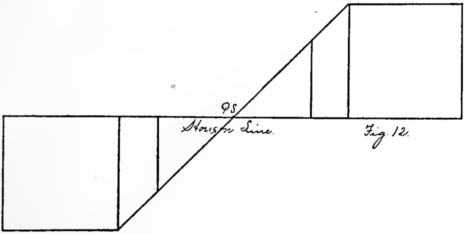


Fig. 12.

Fig 11.

Draw a cube with its upper edge on the horizon line and placed to the left of the point of sight (Fig. 11.)

Draw a cube with its lower edge on the level of the eye and to the right of the point of sight (Fig. 12.)

Draw a cube above the point of sight and in front of the eye.

Observe that if the cube is placed on the horizon line and directly in front of the eye but one face, the front, can be seen which will appear in its true shape, a square, and if placed to the right or the left, whether on, above, or below the horizon line, if *parallel* to the observer, will still appear in its true shape.

It is true that distance to the right or left of the observer will cause an apparent convergence of lines, but as the picture plane assumes to comprehend what can be seen by one position of the eye all objects within the picture plane will be represented in their true shape if parallel to the observer. Otherwise the drawing would appear distorted.

Study again the retreating edges of the row of desks, the aisles, the top of the table, etc., but by placing yourself a little to the right of the objects.

It will now be seen that instead of two sides, we see three, the top, the front, and the left side.

While the point of sight must remain directly in front of the observer, the object is no longer between the eye and the point of sight but it is at one side of both, yet the lines receding from us still appear to converge in that point.

The object must be very carefully studied and all proportional measurements accurately taken to ascertain the exact

amount of convergence, and it is done in this case by means of the pencil exactly as it was done in the first drawing of the cube. When all proportions are carefully noted the cube is to be drawn.

It is not always necessary to draw the horizon line or to indicate the point of sight but they should be constantly kept in mind and sometimes in drawing more difficult objects they may be used to test the accuracy of the drawing.

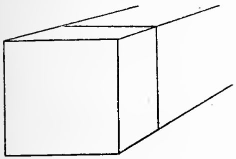
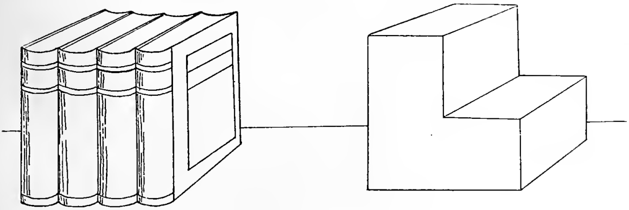


Fig 13

Fig. 13 represents the cube as placed below the eye and to the left of the observe.

The drawing of the cube in this position may be followed by the drawing of boxes, groups of books, etc., placed in the same position.

Do not forget the table line.



Simple combinations of the sphere and cube may now be studied. Draw the sphere a little to the left of the cube and both to the left of the observer (Fig. 14.)

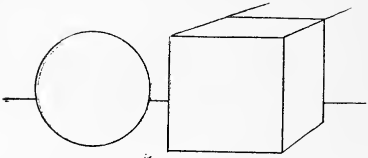


Fig. 14

Notice that the apparent distance between the two objects varies with the position of the observer.

In representing the sphere in front of the cube, the circle must be drawn far enough away to allow for the thickness of the sphere (Fig. 15.)

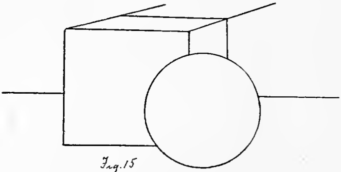


Fig. 15

Remember that objects near the observer are nearer the lower edge of the paper than those that are farther away.

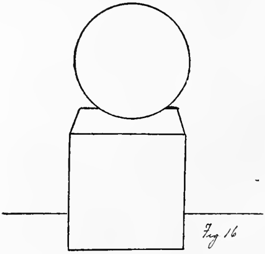


Fig. 16

When the sphere is represented as standing upon the cube, it must be remembered that the sphere would not stand firmly on one edge of the cube but would be most at rest if placed in the center of the top. (Fig. 16.)

In a perspective drawing the center of a face can easily be found by drawing the diagonals of the face, the center being the point at which the lines intersect.

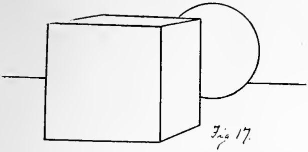


Fig 17.

To represent the sphere behind the cube, we must remember that the sphere being of the same size of the cube will be confined within the extended lines of the cube, and while actually of the same size of the cube will appear to be smaller, because farther away from the eye. (Fig. 17.)

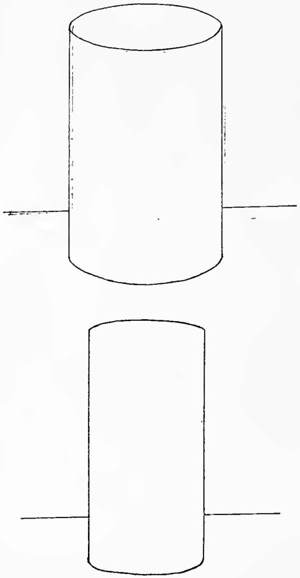
To study the drawing of the cylinder in perspective take a sheet of paper half as long as it is wide, say 6″ by 12″, roll up as a cylinder and pin together carefully so that it can be freely handled.

Hold the cylinder in front of and below the eye so you can see into it, raise it slowly watching the top, and notice that the higher it rises, or the nearer the level of the eye, the narrower the ellipse appears, until the eye level is reached when nothing can be seen but a straight line.

Repeat this several times, raising and lowering it, until you have become familiar with the changes which appear to take place. Notice that the farther below the level of the eye the wider the ellipse appears, therefore the lower ellipse will be wider than the one at the top, and be careful to remember this fact when drawing the cylinder. However, the variations for an ordinary cylinder will be slight.

Great care must be taken in drawing the ellipses that they may be perfectly balanced about their axes.

It is well to draw a center line on which to indicate the width, and to assist in getting a correct form. Draw the com-



plete ellipse at the bottom and when the correct form has been obtained the back half may be erased. The table-line must come somewhere above the farthest edge of the lower ellipse. (Fig. 18.)

Using the paper cylinder again place the top on a level with the eye so that the edge will appear to be a straight line; now raise it very slowly and observe that above the eye the front edge appears to curve upward.

When the middle of the cylinder is on a level of the eye, notice that the top seems to curve upward and the bottom to curve downward. (Fig. 19.)

When drawing the table line it is necessary to put it back far enough to escape the back edge of the cylinder.

Hold the cylinder on the level of your eye again, close one eye so as to look from one point and you will observe that

yov cannot see quite half around the cylinder. (Fig. 20.)

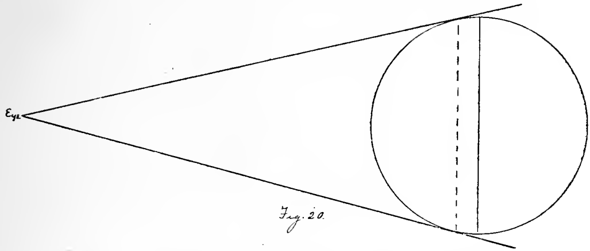


Fig. 20.

Mark the farthest distance you can see on each side without moving the head and then compare with the diameter of the circle. It will then easily be seen that the long diameter, or major axis, of the ellipse will not coincide with the diameter of the circle.

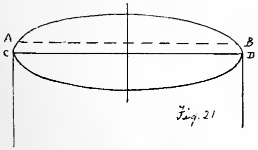


Fig. 21

AB in Fig. 21 represents the diameter of the circle and CD the major axis of the ellipse.

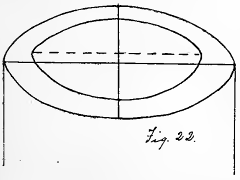


Fig. 22.

Next study the hollow cylinder, and for this it will be best to use a wooden one whose sides are about one-half inch thick. Observe its peculiarities, and notice first that the long diameter of the inner ellipse is not coincident with the major axis of the outer ellipse, and neither of them coincide with the diameter of the circle, but that the major axis of the inner ellipse is nearer the diameter of the circle than is the outer one.

If an indefinite series of ellipses were drawn, the smallest would be found to coincide with the center of the circle.

By studying our cylinder again we find that the rear edges of the two ellipses appear to be nearer together than the front edges, also, that while the true thickness of the cylinder is seen at the ends of the major axis, there is a visible foreshortening directly in front. (Fig. 22.)

It would be well at this point to draw a square and inscribe a circle which touches all of the sides of the square. Have the drawing on cardboard or stiff paper so it can be held perfectly level without bending.

Study the appearance of this figure exactly as you studied the top of the cylinder, and note carefully all apparent variations in the circle, from the straight line, through all the widening ellipses till a full circle is reached. Observe carefully the apparent place of the diameter of the ellipse in the different positions.

Next inscribe another circle whose diameter shall be two-thirds of the larger circle. The circles must be concentric.

Now study again, and find apparent difference of position of the major axes of the two ellipses.

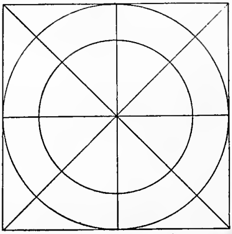


Fig 23

Fig. 23 shows the manner of drawing the figure to be studied.

Fig. 24 shows the card as it will appear when held below and in front of the eye, and by studying it we observe that 1—2 passes through the center of the

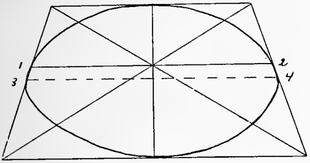


Fig 24

square, which is found by the intersection of the diagonals, and is therefore the center of the circle, but the major axes of the ellipse is some distance in front of this and is indicated by 3—4.

This is explained by the principle that when the figure is on a plane parallel to the eye one line being nearer to the observer may appear longer than the diameter of the circle.

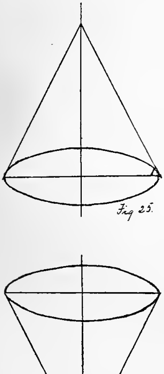


Fig 25.

After careful study of the cylinder it will be readily seen that the cone presents almost no difficulties worthy of the name, however, there are two points to which we wish to direct your attention.

Hold the cone in front of and below the eye and you will observe that you can see *more* than half-way around. (Fig. 25.)

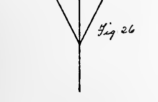


Fig 26

Invert the cone however and it will be observed that you can see *less* than half-way around. (Fig. 26.)

If the cone is held in its true position but above the eye, *less* than half-way round can be seen.

To represent the half-sphere draw first the outline of the whole sphere, then bisect the circle and represent the plane

face as a circle seen in perspective, that is, an ellipse. Figs. 27 and 28 will show what is meant without further explanation.

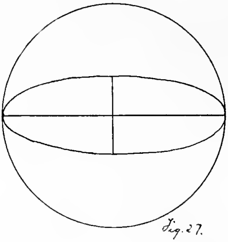


Fig. 27.

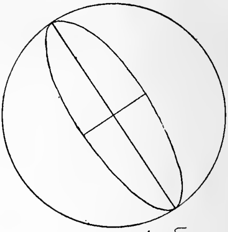
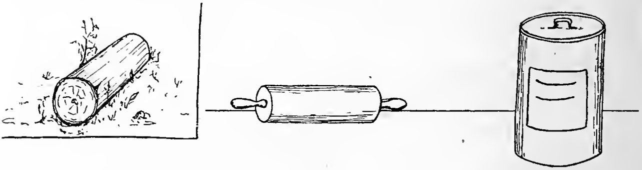


Fig 28

Simple modifications of the type solids will readily suggest themselves and the student will do well to attempt the drawing of such as occur to him, applying, however, the same principles as have been here given.



Remember that *where an edge is there must be a line*, or, in a perspective drawing there must be an ellipse if the object is curved. *Lines also represent outlines* or the parts that appear to be farthest out on the object. (Fig. 29.)

We have already studied the cube in parallel perspective, *i. e.*, with one face or side parallel to the observer, and we must now consider it from another point of view, namely: with an angle turned towards us.

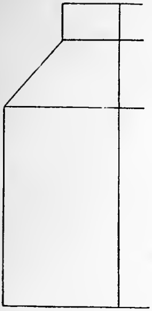


Fig. 29 A

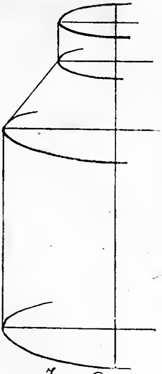


Fig 29 B

This comes under the head of *angular perspective* and gives us several new points to consider.

Place a cube in front of you and study it. Turn it so that one vertical edge will be directly in front of you, that is, between you and the point of sight, and you will at once perceive that none of the edges appear to retreat to the point of sight, but that the edges on the right go to some point in that direction, and those on the left to some point at your left, and that both points must be situated on the same level, or on the same Horizon Line.

It will also readily be seen that if the object is placed directly before the observer, and it is turned at an angle of 45 degrees, that both the edges on the right and those on the left if extended would meet at equal distances from the Sight Point.

These points at the right and the left are called "Distance

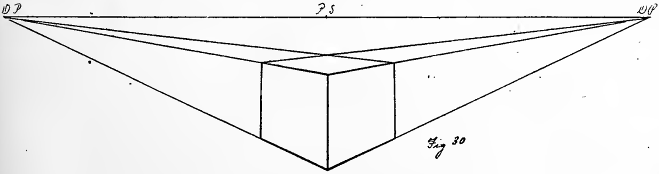


Fig 30

Points," and in drawing, care should be taken that they are not placed too close to the point of sight, unless the result is to be very small, as it would make the drawing appear distorted. At this point in your work it is well to be reminded of an important principle: *All vertical lines remain vertical.*

To draw an object in angular perspective, locate first the nearest vertical line then find or draw the line on the level of the eye. Find apparent slopes of the right and the left upper edges and extend these lines to the distance, or vanishing points. Draw the lower lines to the same vanishing points. Use the pencil at this point to determine the apparent width of the right and left faces and draw their back edges, being very careful that these lines are vertical.

To draw the top of the cube you have only to connect the upper end of the right vertical with the left distance point, and the upper end of the left vertical with the right distance point. If your work is correct in drawing the cube at an angle of 45 degrees the rear angle of the top will be directly above the front vertical.

Study the cube place at an angle of 45 degrees, but moved a little to the left of the observer, and it will be seen that the lines appear to retreat to the same distance points as before, but much more can be seen of one side of the cube than of the other. This difference of apparent width can easily be determined by the use of the pencil for measurements. (See Fig. 31.)

D.P. D.P.

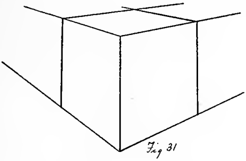


Fig 31

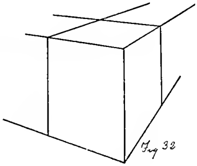


Fig 32

Place the cube to the right of the Point Sight and farther from the observer and note difference in appearance. (Fig. 32.)

Draw the cube to the left and a little below the eye and placed at right angle of 45°. Change to an open box. (Fig. 33.)

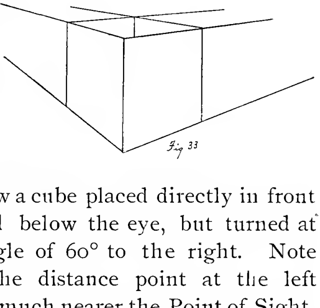


Fig 33

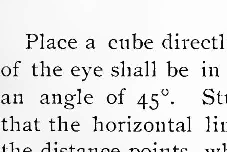


Fig 34

Draw a cube placed directly in front of, and below the eye, but turned at an angle of 60° to the right. Note that the distance point at the left seems much nearer the Point of Sight, and the one to the right seems much farther away. (Fig. 34.)

Place a cube directly in front of you and so that the level of the eye shall be in the center of the cube, then turn it to an angle of 45°. Study convergence of lines and notice that the horizontal lines above the eye retreat downward to the distance points, while those below the eye appear to run upward to the same points. (Fig. 35.)

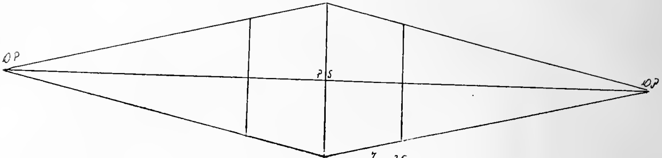


Fig 35.

The square prism and the square plinth may be studied under exactly the same conditions as the cube, and a few examples of each will be sufficient to give a clear idea of their drawing.

In drawing from the model it will be well to remember that the square prism is usually twice as tall as it is wide, and that the square plinth is three times as wide as high.

Draw the square prism standing one square end to the left and below the eye. (Fig. 36.)

Draw the square prism under the same conditions except that the prism shall be placed on one oblong side. (Fig. 37.)

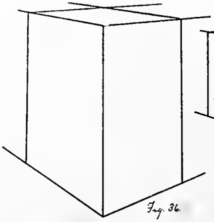


Fig. 36.

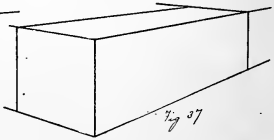
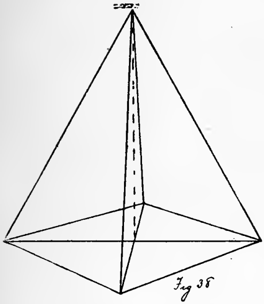


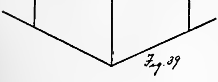
Fig 37



The drawing of the square pyramid does not present any special difficulties. Draw it first as it appears to you, and afterward test your work by drawing the diagonals of the base. If the pyramid is drawn correctly the apex will be situated directly over the center of the base. (Fig. 38.)

The triangular prism should now be studied, but all points may be gained in the drawing of this model as in previous ones, by careful and continual use of the pencil for measurements.

Draw the right-angled triangular prism standing on one triangular base, the right-angle being directly in front of and below the eye.



The drawing must proceed in exactly the same way as for the square prism until the front faces are located and drawn. (Fig. 39.)

If, however, the prism is to be drawn lying on one side and turned at an angle, we have a new point to consider. In parallel perspective we have but one set of retreating lines, therefore but one vanishing point; in angular perspective we found two sets of retreating lines and two vanishing points; now we find three sets of retreating lines and so we must have three vanishing points.

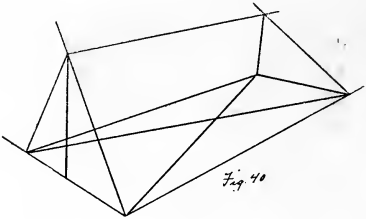


Fig. 40

It will be seen in Figs. 40 and 41 that the lines retreating upward appear to converge and would meet directly above vanishing point 1, or on the horizon of the vertical plane.

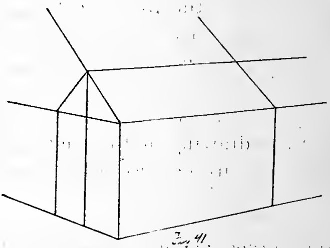


Fig. 41

Tip a cube so that the rear is lifted a little and notice the pairs of parallel lines and their apparent vanishing points, and while we have but two vanishing points this is also in oblique perspective because none of the lines are horizontal to the picture plane, and both sets of retreating lines vanish in a vertical horizon line rather than in a horizontal one. (Fig. 42.)

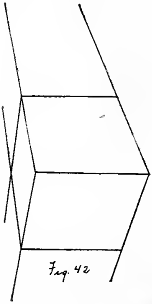


Fig. 42

If a face of the object is parallel with the horizon line it is in *parallel perspective.* If it is placed at an angle and an edge is nearest the observer it is in *angular perspeciive.* If an angle is nearest the eye and all the edges oblique, it is in *oblique perspective.*

In grouping remember that two objects cannot occupy the same space, therefore two ellipses must not entercept one another. (Fig. 44.)

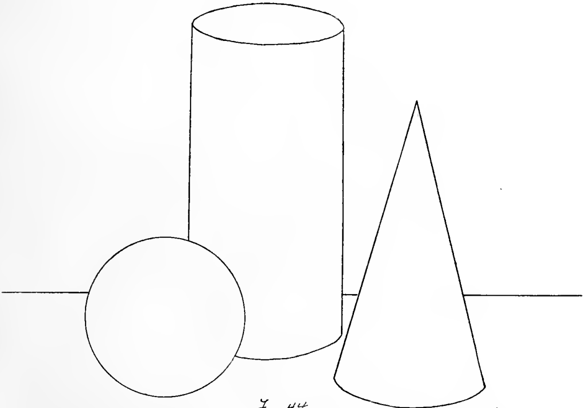


Fig 44

A group should consist of at least three objects, one of which should be larger than the others, or placed in a more prominent position. The objects should never be placed in a straight line. It is well, often, to place the objects in a triangular form, and to have part of them partially concealed behind the others. If any one of the group is inclined, it should have something to rest upon, thus indicating *repose.* As a rule the objects should not be placed at right angles to one another, nor to the edge of the paper.

A few principles of perspective are here given for the student's consideration:

1. Horizontal distance shorten lines.

2. Vertical lines always remain vertical and grow shorter as they recede from the eye.

3. Lines and surfaces presenting a front view appear of their actual form and in their true position.

4. Surfaces seen obliquely are foreshortened in direct proportion to the amount of obliquity. *Foreshortening* is the apparent lessening in width when a surface is seen obliquely.

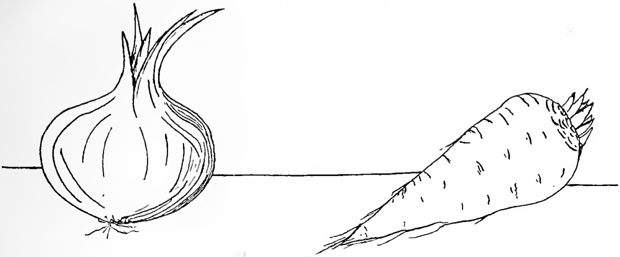
5. Receding horizontal lines, if above the eye, appear to incline downward as they recede; if below the eye, they appear to run upward; if on a level with the eye, they appear horizontal.

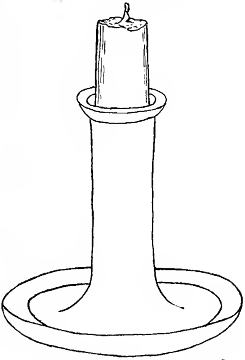
6. Parallel horizontal lines vanish to the same distance points.

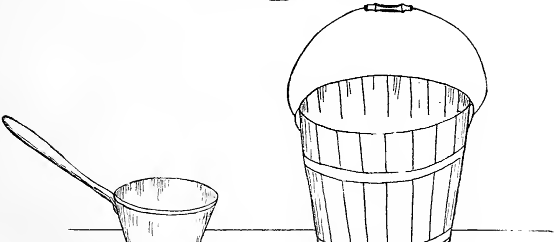
7. Horizontal lines parallel to the line of vision converge to the point of sight.

8. A circle seen in perspective is always an ellipse, or if on the level of the eye, a straight line.

9. Equal circles when seen in perspective will vary in width according to relative distance below the eye. The farther below the level of the eye, the wider the ellipse.







PAPER FOLDING, CLAY MOLDING,

AND

STICK LAYING.

PAPER FOLDING.

Paper folding is of value in teaching neatness, precision, attention, and strict obedience to command, in developing the power and dexterity of the hand, and in training the eye to see accurately and the mind to judge correctly.

Paper folding is done with squares, triangles, oblongs and circles. The paper must be very accurately cut in order to insure good work.

Squares four inches in size are ordinarily used, though for some forms it is well to use six inch squares.

Have the paper laid upon the desk with one edge nearest you. Always fold from you and never take the paper from the desk in folding if it is possible to avoid doing so.

From the square placed before the pupil, teach terms, edge, corner, upper edge, lower edge, upper right and left, lower right and left, applied to corners.

Fold the lower edge of the paper to the upper edge. Turn the paper and hold it partly open and let the children read stories from their "books."

A square of white paper may be folded in the same way and then pinned neatly inside of the colored square. The children may write a little story and their names in the book. Let pupils draw a picture of the book on the board.

Fold another square like the first, open it, and teach term *diameter*. Turn the paper so that the crease will point

towards you and fold the lower edge to the upper edge. Open, and you have a window with four panes. Let pupils draw upon the board.

Note. Dash lines indicate creases, but when the pupil draws upon the board he will make all his lines full lines.

Fold a square as above, turn the paper cornerwise, and fold the corner nearest you to the upper corner. Open. Teach *diagonal*, and review *triangle*. The children if questioned, will tell you they have made a *shawl*. Open the paper, turn, and fold the other diagonal. Open and note triangles, and let pupils draw upon the board. We sometimes get this form of window in the upper end of a house or barn. (Fig. 1.)

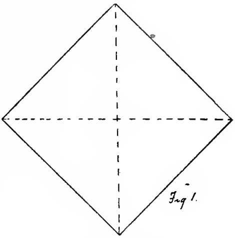


Fig 1.

Using the same square, fold the corners to the center of the square. Open one corner and you will have the open envelope.

The use of little gilt stars to fasten the three corners together, letting the star project so the fourth corner may be folded under it, adds much to the child's delight, and may be used as a stimulus to neatness and accuracy by placing them only upon the neatest and most accurate folding made in the lesson.

Let pupils draw the closed envelope on the board, let them draw the open one also, then allow them to write a little story, fold, and place within the envelope.

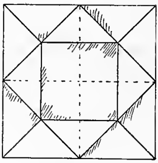


Fig 2

Fold the diameters and diagonals of a square, fold the corners to the center; the result being the same as the closed envelope. Without opening turn the folding over. Turn the small square cornerwise, and fold the corners to the center of the square. Care must be taken that the paper does not slip or crush, but folds easily in the creases made in the folding of the diagonals. Fold the corners to the center of the sides. Result—a picture frame. (Fig. 2.)

Let the children have these foldings to take home, and many of them will bring them back to show the little pictures they have framed in them.

Many of the foldings as taught in the kindergarten are in series of six, each one of a series being one step in advance of the preceding one. A few of these series are given and many others can be made by the teacher by exercising a little thought and ingenuity.

Take a square, fold the lower edge to the upper edge, open the paper, fold the lower edge to the middle crease, turn the paper so that the upper edge will be nearest you, fold this edge to the middle crease, and open the paper and there are disclosed four oblongs. Turn the paper so that the creases will bevertical, fold as before, and open, and sixteen small squares will be seen. All the series here given will start with the sixteen small squares. (Fig. 3.)

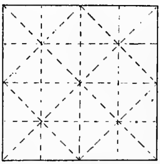


Fig 3

Fold one diagonal, open, fold the other diagonal and open the paper. Turn the paper over. At this juncture much depends on turning the paper over. Turn the corners to the

center of the square. Open the paper very carefully, turn it over and stand it on the four corners. (See Fig. 4.) Taking hold of one corner, tap lightly on A, and let the creases bend downward at this point. Repeat at each corner, and you will have the basket. (Fig. 5.)

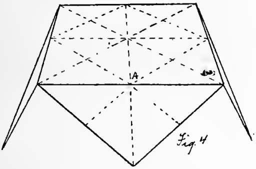


Fig. 4

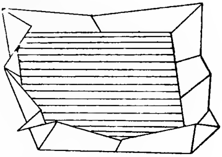
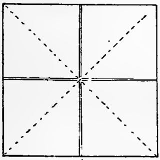
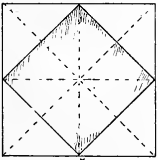
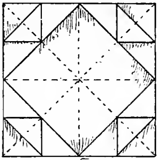


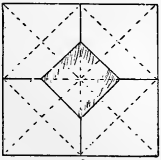
Fig 5.

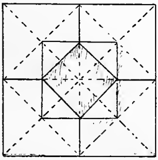
Turn the middle of each side to the center, and fold the corners as squares. You will then have one square on the back of your folding and four small squares on the front. (Fig. 6). This is No. 1 of the first series. No. 2 is formed by turning the corners back to the corners of the large square. (Fig. 7.) The remainder of the series are shown in Figs. 8, 9, 10 and 11.

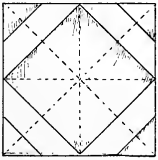

6.


7.

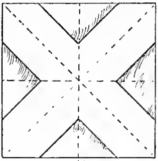

8.


9.

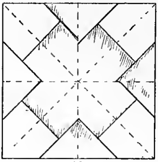

10


11

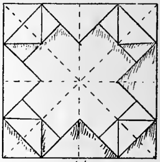
The next series begins like the first and progresses in the same order until Fig 6 is reached. The six figures are illustrated in Figs. 12, 13, 14, 15, 16 and 17.



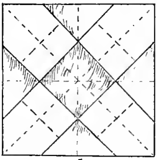
12



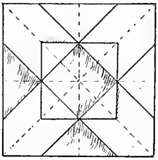
13



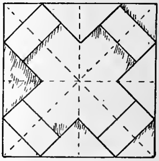
14



15

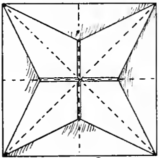


16.



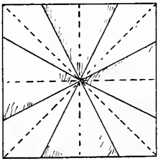
17

Series 3 begins as the first series did and continues the same till Fig. 6 is reached. The small squares are now folded from their outer corners to the center of the sides. (Fig. 18.) The series continues in the same order as the preceding ones.



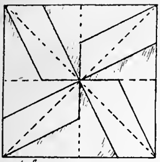
(Series 3) 18

Series 4 is folded in the same manner as the others until Fig. 6 is reached. The small squares are now folded obliquely from the center of the large square to the center of the side of the small square. Fig. 19 will show the first of this series. The remaining steps are like those already shown.



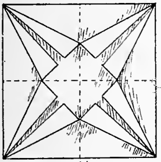
(Series 4) 19

Series 5 is folded like the others till Fig. 6 is reached, and then it becomes a combination of Series 3 and 4. The corner of the small square is folded from the outer



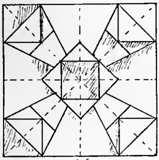
(Series 5) 20

corner, and the opposite corner is folded from the center. (Fig. 20.) The succeeding steps are the same as heretofore.



21.

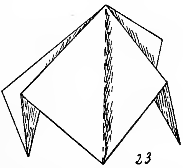
These series may be varied or added to in numberless ways. Fig. 21 shows one similar to Fig. 18, except that the corners are turned outside instead of being hidden as in Series 3.



22.

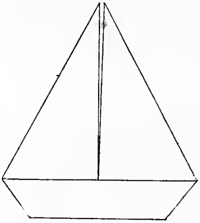
Many variations may be made by folding the small triangles in the center. Fig. 22 will illustrate this.

To fold a boat with two sails, fold one diameter, open, fold the other diameter and open. Turn the paper over, and fold both diagonals taking care to open the paper each time. We find by taking up the paper that the diagonal creases bend outward and the diameters toward the inside of the paper. Hold the paper lightly in the hand with the corners turning upward. Push lightly on the spot where the creases intersect until it forms the top and the corners turn down. (Fig 23.) Draw the right and the left corners together, press down the two outside squares and you have a small square showing. Turn the paper around and hold by the corner which coincides with the center of the large square. Take the upper corner of the square nearest you and fold to the lower corner. Do the same to the qsuare at the back. This will leave the two sails standing.

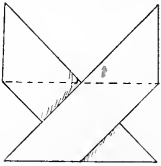


23

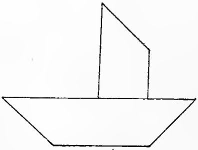
Lift up the corners of the squares just folded down and fold back to the center creases. Now take the heavy triangle remaining and fold it to the center crease. The three foldings at the bottom must be hidden and the creases firmly pressed down to make the bottom of the boat firm. Let the pupils sail their boats on their desks by blowing them gently along. Fig. 24 shows the completed folding. This folding forms a very good subject for a drawing lesson, and also for a language lesson.


24

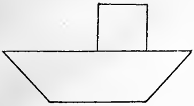
With another square fold the sixteen small squares and the diagonals, turn the paper over and fold corners to the center. Proceed until Fig. 5 is reached. Push centers of sides together and holding lightly in both hands, fold on one diagonal of the small square at the back. Fold on the diagonal of each small square, letting one come to the right and the other to the left. For this folding the children have several names, saw horse, vase, etc. The children like to press flowers and fasten them in their vases. (Fig. 25.)


25

To make a boat, fold as for Fig. 25. then turn the lower right corner back to the lower left corner. (Fig. 26.)

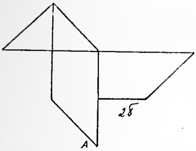

26

For a woman in a sun-bonnet sitting in a boat, fold as for Fig. 26, then fold the upper triangle inside. (Fig. 27.)



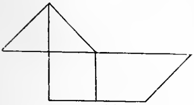
27

The chicken (Fig. 28) is folded from Fig. 26, by opening partially and turning the triangle at A wrong-side out and letting the other parts remain as before.



28

The duck (Fig. 29) is made by folding as in Fig. 28 and then opening the squares at A and folding back to the sides.



29

Some beautiful work may be done by using equilateral triangles, four inches on a side. The folding is so much like that for the square that it will be unnecessary to explain except by a few illustrations. (Figs. 30, 31, 32.)

32

31

30

CLAY MODELING.

Clay modeling is valuable as a means of form study. It cultivates observation and judgment, trains the eye, and develops the dexterity of the hand.

Artists' clay is no doubt the best to use, but for all ordinary work common potters' clay serves every purpose.

If clay is obtained at a pottery it is usually sent in a moist condition, and for a time requires no care except to keep it damp. Clay that is bought from school supply houses is sent dry and must be prepared by the teacher. If the clay has been purchased damp, wrap it in several thicknesses of wet cloth and place in a stone jar. When ready for use it should be of the consistency of stiff dough. If dry the clay must be pounded till reduced almost to a powder. Place it in a large cloth and tie it up. Put it in the jar and pour over water enough to cover the mass. Let it stay in the water several hours then take out the bundle and, without untiyng, work the clay. This can be done in two ways: knead it as you would bread, or pick it up and drop it, turning it every time. A combination of the two ways is always good. When the clay has become smooth and plastic, it is ready for use. If the clay is too hard, moisten it again by pouring a little water over it and kneading it again. If it is too moist it must be allowed to dry off.

Clay is like dough in that it is experience alone that can tell you when it is exactly of the proper consistency. When it is just dry enough not to stick badly to the hands, take it

out of the cloth and by lifting and dropping or by pounding it shape it into a brick. It is then ready to cut.

Cut the clay with a strong, fine string or wire, the latter being preferable, into cubical pieces for the children. Inch cubes are large enough for the usual molding.

A piece of oil cloth or paper should be spread upon each desk to protect the surface. A smooth board 12″ by 18″ will be found of great service to hold the clay when preparing it for the class and also in collecting the clay.

Children begin by molding the sphere, the first of the type solids. The block of clay is taken in the fingers and the shape produced by quick, light touches of the fingers and a continual turning of the mass—that is, by "finger manipulation."

Sometimes the sphere is produced by rolling in the palms of the hands, but this is a more mechanical process, and does not cultivate the sense of touch as in the use of the fingers.

It is necessary that the children have the small wooden models on their desks where they can compare their work with the perfect type.

The next type solid is the cylinder, and this is best modelled by *building up*.

The child takes a small piece of the clay, with the fingers presses it into a small circular disc, and places it on his desk. The cylinder is built up on this base, not, however, by making a series of discs and placing upon one another but by adding small irregular lumps and shaping to the general form after adding to the cylinder. In this method of working it is not necessary to take the work from the desk, but the cloth or paper on which it rests can be turned like a revolving table so the child can see all sides in turn.

The tendency will be for the child to make his model smaller at the top, but this can be corrected by calling his attention to that point. By light touches with the fingers and smoothing a little, all traces of joining can be obliterated.

This method of working is preferable to obtaining the form by rolling, as there is not the likelihood of getting the hollows in the ends by too much rolling, or of making the ends project by too much patting of the ends to obtain the flat faces.

The cube is the third and last of the type solids.

When giving out the clay for this work it is better to give it in irregular masses than in the neatly cut cubical blocks. The reason for this is obvious. If the teacher it very skillful in cutting the clay, she has left the child too little to do, if she is not expert she has confused him by an apparent likeness. The cube should be built as the cylinder was, and carefully worked with the fingers to obtain sharp, clean edges and corners. The method formerly used of tapping the clay on the desk or of striking it with a flat stick, may, and does produce oftentimes a good form, but at the expense of many other valuable considerations. The noise also distracts attention from the result to be obtained and has been known to make the pupil more solicitous about the amount of physical energy he is to use than of the true object of the lesson.

The half-sphere is obtained by modeling the sphere and bisecting it. This is best done by the use of No. 60 thread. Take a piece about four inches in length, straighten upon the desk and lay the sphere carefully upon it. Draw the thread up by both ends, tie in a single knot and slowly and carefully draw the knot close to the clay. See that the

thread lies evenly around the sphere and when accurately adjusted pull steadily outward with both hands.

The half-cube is obtained by cutting the cube on one diagonal.

The half-cylinder by cutting the cylinder vertically.

The square prism by cutting the cube on both diameters of the base.

To obtain the circular plinth quadrisect the cylinder horizontally.

To obtain the square plinth mold a large prism and quadrisect horizontally.

The right-angled triangular prism is obtained by cutting the square prism on one diagoual of the bases.

MODIFICATIONS OF SOLIDS.

Sphere—Apple, bead, cherry, baseball, grapes, vase, sugarbowl.

Cylinder—Firecracker, mallet, rollingpin, bottle, pump, mug, water cooler.

Cube—Bead, box, basket, bureau, ink bottle, house.

Half-sphere—Half-apple, bowl, basket, cap, toadstool.

Half-cylinder—Cradle, log of wood.

Square prism—House, pump, coffeemill.

Triangular prism—Roof of house.

Square plinth—Cracker, box, book.

Circular plinth—Cakes, checkers, coins, cake basket.

Flat spheroid—Turnip, beet, bonbon box, muskmelon.

Long spheroid—Potato, lemon, melon.

Cone—Oil can, funnel, churn, coffeepot, wineglass.

Ovoid—Egg, pear, gourd.

STICK LAYING.

Stick laying is of value in the teaching of form and arrangement.

The first work in stick laying in form study comes after the type solids have been studied.

Review terms: vertical, horizontal, oblique, square, triangle, oblong, diameter and diagonal, using sticks.

Simple historic borders are also made, either by following the teacher who works at the blackboard or by dictation.

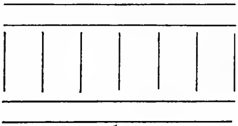


Fig 1

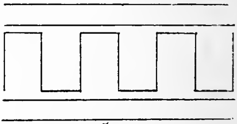


Fig 2

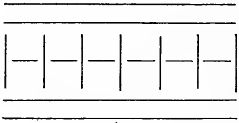


Fig. 3

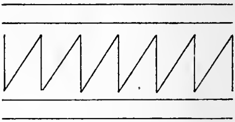


Fig. 4

Figs. 1, 2, 3 and 4 will give some idea of work in borders. Long sticks may be given for enclosing lines. Fig. 5 will give suggestions for advance work in borders.

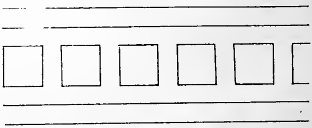
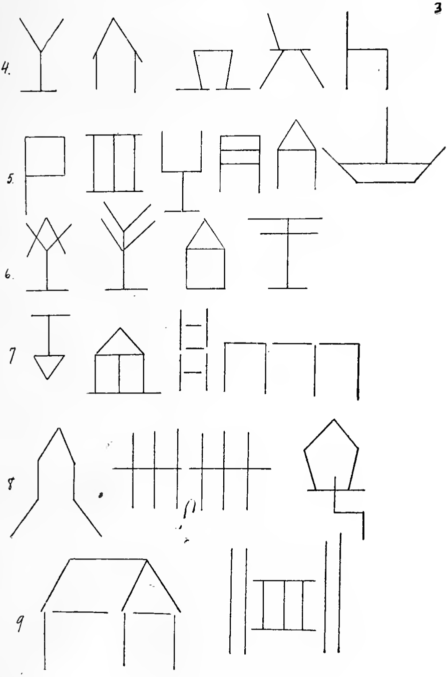


Fig 5

Below are given some arrangements, with 4, 5, 6, 7, 8 and 9 sticks. This can be done from the blackboard or from dictation and the pupil must be encouraged to do original work.



The study of angles may be made interesting by using sticks, combining not more than three sticks to make angles up to twelve. It is impossible to make eleven angles with three sticks. Let the children dot the angles.

Radial designs may also be made.